CHEMICAL
& METALLURGICAL
ENGINEERING

Conferees Report
On the Tariff

ANOTHER turn was given to the kaleidoscope of tariff legislation last week when the conferees agreed upon the dye embargo and revised the ad valorem and specific duties on intermediates and dyes. On the face of it this is favorable to the chemical industry and gives a new lease of life to the embargo. It is questionable, however, whether the action will be approved by either the House or the Senate. The only certainty is that the change will precipitate a fight in both houses.

It will be recalled that the Fordney bill eliminated the embargo altogether; that the Senate Committee on Finance restored it, but that the Senate finally rejected it after a spirited debate. The only way in which the conferees could revive the issue was by eliminating the section in the Senate bill which authorized its repeal. There is a question whether this is permissible under conference rules, so that a fight will be waged not only on the embargo itself but also on the validity of the conference agreement. Meantime the Bursum amendment, carrying high ad valorem and specific duties, has been rejected, and it is impossible to foresee at this writing how the dye industry will come out of the mêlée.

Government Files Suit
Against Chemical Foundation

CHARGING conspiracy to create a dye and chemical monopoly in the United States, with the Chemical Foundation as a device for acquiring German patents, the Attorney-General on Sept. 8 filed a suit in equity in the United States District Court at Wilmington, Del., against the Chemical Foundation, Inc., demanding a return to the Alien Property Custodian of all German patents and other rights held by this organization. An analysis of the complaint, which covers more than 500 printed pages, including exhibits of several hundred pages, reveals the line of attack on which the government will proceed. In the first place, it is alleged that the price paid for the patents by the Chemical Foundation was grossly inadequate, so much so that if the sale is sustained it would constitute confiscation and a violation of trust. Next, the government attacks the authority under which the sale was made and the validity of an executive order by President WILSON attempting to validate certain acts of the then Assistant Secretary of State. It is claimed that both of these officials were unaware of the facts in the case when taking their actions and that the Chemical Foundation through its representatives "put something over" on the government.

The conspiracy phase of the government's suit is a most interesting one, because it brings into the controversy not only some leading chemical manufacturers but also certain trade associations and technical societies, naming them all as conspirators in the creation of the Chemical Foundation, which was to pull German chestnuts out of the fire for American chemical industry. No less interesting is the charge that these conspirators hoodwinked the government by misrepresentation or only partial representation of the facts. This is the government's side of the story, and it is evident that it calls for considerable light which the Chemical Foundation's answer undoubtedly will shed on the whole matter.

Public Appreciation of
Chemical Warfare Service

EDUCATION of the public takes time. This is strikingly illustrated in the attitude of the people generally toward the Chemical Warfare Service, regarding which a large amount of information has been printed in the last 4 years. In 1918 the American public had no other idea than that the use of gas in warfare was barbarous in the extreme, with no redeeming feature. To dislodge that conception from the minds of 110,000,000 people has been a task of unusual difficulty, but General AMOS A. FRIES, Chief of the Chemical Warfare Service, believes that a majority of the people at last have been brought to estimate the value of the service more accurately.

Information reaching the Chemical Warfare Service directly and the opinion of Senators, Representatives and other officials who are in close touch with the people all lead to that conclusion. It is believed that this feeling will be strengthened as the public learns that the peace-time activities of the service carry with them great possibilities in the public interest. For instance, the Chemical Warfare Service, with the aid of representatives of the Public Health Service and of the Navy, has developed a substitute for hydrocyanic acid gas which removes all danger of accidental death from the use of that gas as a fumigant. The substitute is cyanogen chloride, which is a powerful tear gas when used in concentrations of only one-eighth the amount necessary to cause death. As soon as sufficient supplies of the new gas are available, it will be used exclusively by the government in the fumigation of ships.

Encouraged by the success of the experiment with cyanogen chloride, the chemists at Edgewood Arsenal are now getting encouraging results from experiments in mixing a sneezing gas with illuminating gas so that sleeping persons will be awakened in case unburned illuminating gas should escape in the room. The property of the gas which causes sneezing is destroyed when the gas is burned. Progress continues to be made in the use of poison gas against insect and rodent pests, notable work having been done recently in combating

locusts in the Philippines. Work is also continuing in the hope of finding a successful way of using gas in the eradication of the cotton boll weevil. All of which leads to the confident belief that gas will be found to be the most effective weapon that can be employed in the fight on insect and rodent pests. Thus are the means of war converted to the uses of peace; and meantime the knowledge gained will be a comforting asset in time of emergency.

The Universal Curse—Work

THE basis of the philosophy both of the men who exercise creative intelligence and of the great mass of the workmen, both skilled and unskilled, is the same: "Work is a curse." The practice growing out of the philosophy is different. The investigators and inventors are endeavoring to lessen the amount of work that has to be done to compass a given quantity of production, by improving methods, by finding short cuts. The workman is endeavoring simply to reduce the amount of work he must do individually without reducing the compensation received.

This is not a case of different reactions to environment, for the environments are different. One cannot assert that if men were to change places the reactions in the environments would be changed.

We appear to be, on the whole, sadly lacking in the application of psychology. There is much criticism of workmen for wanting to do less work and for wanting to get more pay for what they do. Great economic truths are hurled at them, with no results measurable by instruments of the present standard of sensitiveness. We poke fun at the remaining men who believe that breaking windows is good for business because it makes work for the glazier. Only the densely ignorant can have such a viewpoint, we opine. Yet we have a group of men, elected by men and women who must have thought the candidates possessed some intelligence, who have passed a tariff act plainly based on the philosophy that we want only so much work to be done, and that if we permit foreigners to do any of it we shall have so much less to do ourselves.

The captains of industry, the *entrepreneurs*, the employers—to name more specifically a class—should not expect employees and workmen to have a different philosophy than they themselves have. They all believe that work is something to be avoided, provided the results or rewards are still obtained, and that belief cannot be eliminated as a basis of conduct. It is a fact that must be recognized.

The burden of improvement rests not upon artisans or unskilled workmen, but upon those who invent and devise. Hitherto the activities of the men of creative intelligence have been directed chiefly to reduction in the total quantity of work to be done to achieve given results. They would like, to give an illustration, to replace a gang of four men by a gang of three men, each of the three men working as hard as each of the four men had to work. There is another field, little considered, that of making the work of the four men less irksome, whereby these four men become more contented than are four other men who are working the old way and who become ambitious for promotion to the less irksome work.

The general principle involved, that work should be made less irksome, is universally recognized. The most obvious proof of this recognition is the large part played in "welfare work" by the providing of amusements.

Undoubtedly all such efforts, if intelligently directed, are good, but it is plain that they represent an open confession by the employer that the work of the employee is irksome. They improve conditions, no doubt, but at the same time they emphasize in the mind of the workman the point that improvement is confessedly desirable. No competition among workmen is produced, the benefits of welfare work being open to all. When, however, some jobs are made less irksome than other jobs, competition to possess the better jobs is stimulated.

A Survey Of Business

"THEY are shipping niggers (*sic*) from Birmingham by the trainload."

"California is prosperous. People must eat, and the West can always feed them."

In addition, there were a number of men who thanked whatever gods there are that they still hold their positions. All these, and many more, are the concomitant joys of an editorial survey of general business conditions that we have recently completed. We asked whether business was good, fair or poor. We asked whether unemployment was increasing or decreasing, and we further inquired whether the addressee was employed. We addressed our inquiry to technical men, distributed all over the country. Some of them are not technically trained, but all of them have a technical background. They are engaged largely in manufacturing, and the products are in general connected with chemical or metallurgical industries.

A gratifyingly small number of men reported that they were unemployed. It is reasonable to assume that a relatively large percentage of unemployed men would answer a questionnaire of this kind, and it is probably safe, therefore, to assume that 4 per cent is a high figure for unemployment among technical men.

All sections reported unemployment decreasing. The West was apparently surer of it than the East, for over 75 per cent of the men from the Middle and Far West reported unemployment on the decrease. In the East, 66 per cent believed that more men are at work now.

The accompanying table represents the opinions received on business conditions. The similarity of the replies from the different sections of the country is striking, and a healthy note of optimism is apparent. That business should be reported good in over 30 per cent of the total replies is certainly encouraging. A slightly higher optimism, whether of temperament or of fact, is to be noted in the Middle and Far West, but the similarity is rather more striking than the slight difference.

Business Is	East, Per Cent	Middle West, Per Cent	Far West, Per Cent
Good..........	25	32	30
Fair..........	65	62	58
Poor..........	10	6	12

Those industries which were reported as "enjoying" poor business were made a subject of special study. It is quite reassuring, because no one industry was mentioned frequently. Individual companies seem to have a continuation of lean years in dyewood extracts, dyestuffs, copper, zinc, beet sugar, machinery, soap, brass, etc. The striking thing, however, is not that individual companies are having hard times but that hard times are not general and that they are not confined to any particular industry.

It is somewhat unwise to overemphasize the value of such a survey. The opinions undoubtedly are casual,

and yet the men have intimate contact with their industries. Many of them are production heads, and all of them are engaged in production work. It is perhaps fair, then, to assume that the opinions have more weight than a casual opinion ordinarily would. The indication is that, disregarding enforced idleness through strikes, the country is on the road to business health.

Building
With Foresight

RATIONAL, scientific plant design and layout are more often notable for their complete absence from the chemical plant than for their presence. This has been largely brought about by the circumstances under which chemical industry has developed—circumstances which preclude the use of any effective prevision.

Some of the points made by contributors to *Chem. & Met.'s* recent Exposition issue bring this situation clearly before the reader; and we feel that the course of conduct which would follow a complete realization of the present situation and the remedies for it is one that can be profitably considered by all those who can help to put it into effect.

Among other contributors, FRANK D. CHASE, in referring to this lack of forethought, said:

"The result has been in most plants a hodge-podge of buildings built one at a time without reference to co-ordination of manufacturing operations; without thought for future growth, either as a whole or for single units or departments; and without thought, in very many instances, of the physical comfort and welfare of employees."

A. E. MARSHALL, in his contribution on the design of chemical plants, expressed the need of this foresight in the following words: "In considering the design of a new plant, the chemical engineer has several important factors to take into account. One which has received least attention in the past and which has caused later on in the life of chemical plants either unnecessary cost of product or prevented possible reduction is the lack of provision for future expansion."

It seems axiomatic that each owner of a chemical plant desires his business to grow. A static condition is but little better than a reduction of business and a healthy growth is one of the requisites of real success. If the product which is manufactured is worthy and well marketed, the plant will inevitably be faced with a demand for increased output.

If the original plant was not built with this end in view, there seem to be only two ways open to meet this situation. Either a complete new plant can be built or additions can be crowded into the existing plant wherever an available corner can be found. Neither of these expedients has the effect of lowering the costs in the degree that could reasonably be expected to follow increased output.

How much better, then, to provide for a reasonable expansion at the time the plant is built. If this is done, capacity can be added as the need for the increase occurs. Such an expansion invariably results in more output per unit of labor; and there are certain features of the plant which will not have to be duplicated, but can serve the increased capacity as well as they did the original. The result of this is the reduced production cost that should always follow increased output.

One of the greatest of engineering firms has adopted as its slogan the words: "BUILDING WITH FORESIGHT." It may have the use of this phrase copyrighted for advertising purposes, but its application to industry is open to all. Let chemical industry adopt this as its watchword and by the use of an intelligent prevision escape the recurrence of the mistakes of the past.

Opportunities in
The Leather Industry

AS MODERN chemical science has developed, workers in the different industrial fields have been quick to apply promising concepts to their own problems in the hope of obtaining a clearer understanding of the processes involved. Where it has been possible to determine the fundamentals, progress has been invariably rapid and often phenomenal. In some industries the required information became available at a fairly early period in the growth of the science, while others find even present knowledge inadequate.

Typical of this latter group is the manufacture of leather, which is still largely an art. Through practical experience, supplemented by knowledge which has accumulated as a result of centuries of experimentation by methods of elimination or trial and error, the tanner is able to manipulate successfully and profitably complex reactions, the mechanism of which still baffles the chemist. Progress in an art is often due to the application of methods quite similar in principle to those by which a science advances. Indeed, the progressive tanner has really employed scientific methods in attempting to trace cause and effect in the maze of variables confronting him, so that in this sense there may be said to be a science of leather manufacture.

Of necessity, development in this empirical way has been slow, and real progress will not result until the fundamentals have been established. At present, in spite of the excellent pioneer work which has been done, even a chemist whose training has included the latest developments of physical chemistry, the chemistry of proteins, tannins, colloids and of bacterial and enzyme action, will find difficulty in studying many of the reactions which take place. Attempts at process improvement by chemists with inadequate training have so often resulted in disaster that many tannery chemists find their efforts confined to laboratory control methods, where again the lack of fundamental data forces them to adopt empirical makeshifts. While control methods are necessary, there is so much work of more vital importance to be done that it would seem that there is a decided tendency among American leather chemists to place undue emphasis on analytical methods.

Fundamental work of the character discussed has been started within the last few years, but many of the results will require intelligent interpretation and application to plant conditions before the tanner will benefit. Herein lies an opportunity for chemists equipped with the thorough modern training which will enable them to qualify. As the industry is not sufficiently aware of its own needs to seek such men, they will be compelled to take the initiative. No small part of their task will be to convince the tanner that chemistry has something more to offer than analytical methods—that it can co-operate intelligently in the improvement of processes—but once this is accomplished both the industry and the status of the chemist within the industry will benefit. For the chemist will not receive proper recognition in the leather industry until he is able to stand shoulder to shoulder with the tanner in the development of the manufacturing processes to their highest efficiency. The field is open and the rewards are certain for those who have the ability and the determination to make good.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, Aug. 21, 1922.

THERE is little to report in regard to chemical markets, which are just recovering from the usual effects of the holiday season, but on the whole demand continues to improve and the outlook is promising. The export trade has been adversely affected by the collapse of the German exchange and a further depreciation is expected. This, it is thought, may have a beneficial effect upon exports to non-European countries. Although the price tendency is upward, the standard prices for soda products have recently been reduced, while the increase in price fixed for the current season by the Sulphate of Ammonia Association has been less than was expected under present circumstances. Coal-tar products are an uncertain market, but pitch is very firm and makers are holding back supplies. Arsenic compounds and particularly zinc oxide have been in good demand, depleted stocks and a rise in the price of spelter being mainly responsible in the latter case. The new trade index, "Where to Buy"—Everything Chemical, referred to in my notes for May, has now been published and was favorably received by the trade. This and other publications are symptomatic of a distinct tendency for better organization and effective propaganda in the chemical trade.

A NOVEL DESIGN FOR NON-RIGID FILTER PRESSES

Gavin A. Renton has worked out the details of a non-rigid type of chamber which enables the cake between the plates to be subjected to additional pressure by squeezing the whole press together after the completion of the normal filtering operation, like a concertina. Metal hoops forming a nearly complete circle in section and surrounding a rubber core are used as distance pieces between the filter press plates. Using vanadium spring steel with a high elastic limit, the relation between the dimensions and thickness of these hoops has been carefully worked out in order to give correct results. In a given case the normal thickness of the cake can be reduced from $1\frac{1}{2}$ in. to $\frac{3}{4}$ in., using metal filter cloth, and in certain cases a non-rigid press of this type should have distinct possibilities.

YET ANOTHER PROCESS FOR CHEAP HYDROGEN MANUFACTURE

The synthetic ammonia industry is mainly responsible for the development of commercial methods of hydrogen manufacture, the two main sources being coal and water. Electrolytic hydrogen is dependent upon very cheap water power, and water gas made from coke has been the main source of hydrogen in this and other countries with adequate coal supplies. Claude has proposed to remove the hydrogen from coke-oven gas by fractional liquefaction, but in making coke-oven gas only about one-quarter of the hydrogen is liberated, whereas many coals contain about 5 per cent by weight of hydrogen, equivalent to about 20,000 cu.ft. per ton. Jaques & West are now developing a new process which is likely to give the maximum possible yield of hydrogen per ton of coal, this being attained by combining in a single apparatus the distillation of coal, the formation of water gas from the resulting coke and the conversion of all carbon monoxide into carbon dioxide and hydrogen by reaction with steam in the presence of a catalyst. The carbon dioxide is removed by absorp-

tion in water under pressure. An experimental plant, consisting of a modified form of Tully complete gasification plant, is now in operation in the north of England, the hydrogen present in the coal being very completely liberated by passing the crude coal gas through the hot zone in the producer, so that the tar, oils, methane and other hydrocarbons are "cracked" or split up into hydrogen and carbon, the carbon reacting with steam to form water gas. The catalyst used is stated to be cheap and reliable and a yield of about 45,000 cu.ft. of hydrogen per ton is stated to have been obtained at a cost of rather more than 1 shilling per thousand cubic feet. It is suggested that the mixture of hydrogen and nitrogen in the proportions required for synthetic ammonia manufacture may be obtained by adding a measured quantity of air to the hydrogen and passing the mixture over a catalyst so that combustion takes place quietly.

STAINLESS STEEL FOR CHEMICAL PLANT

Independent investigations in this direction have been proceeding for some months, but Thomas Firth & Sons, Ltd., of Sheffield, has rendered a service by publishing a textbook on data from investigations carried out in its research laboratories. This book can be recommended for study by all who have the development of chemical plant at heart, and it is particularly interesting to notice occasional differences in the properties claimed for Firth's products as compared, for instance, with Krupp's V2A steel. The most striking of these is perhaps the non-magnetic properties of V2A and the claim that it can be autogenously as well as electrically welded. The most outstanding features are the complete resistance of the new material to caustic alkali, ammonia, copper sulphate and nitric acid of various strengths, its use for optical purposes and its capacity for withstanding high temperatures without excessive loss of strength. Curiously enough, acetic, citric, lactic and tannic acids will attack stainless steel, but natural products such as vinegar, lemon juice, sour milk and tanning extracts, although containing these acids, are without action. The material should be increasingly used in the chemical and other industries, particularly if further researches are generally published and if it should be possible to spray or deposit the metal. The question of price is of considerable importance and at present seems to be in the neighborhood of one dollar per pound. Firth & Sons and also other firms have, however, been developing another variety, which may be termed stainless iron and described as an iron-chromium alloy with a carbon content of under 0.1 per cent. It should be possible to market this and similar soft metals at about half the above price.

GENERAL NOTES

In my contribution for March of this year I referred to the controversy regarding the presence of carbon monoxide in coal gas and meanwhile Prof. H. E. Armstrong has been investigating the carbon monoxide content in tobacco smoke. Experiments made at the South Metropolitan Gas Co. showed that cigar smoke contained 5 per cent and upward of carbon monoxide, while pipe and cigarette smoke averaged about 1 per cent. Rapid smoking considerably increased the carbonic oxide content.

Max Muspratt is the new chairman of the Association of British Chemical Manufacturers, succeeding Sir John Brunner.

The Artificial Silk Industry

A Concise Review of the Development of the Various Processes, With a Discussion of Their Relative Merits and a Summary of Patent Literature

· By Hugo Schlatter

FROM time immemorial man has made use of a variety of animal and vegetable fibers for covering and adorning his body. By careful spinning, bleaching, dyeing, artful weaving and knitting, he has tried to improve and better adapt them to his uses; but it has been only in recent years that he has attempted and succeeded in imitating any of them. It is natural that these efforts of imitation should have been concentrated on silk, the most beautiful and costly textile material.

Natural silk is the product of the silk moth, *Bombyx mori*, and a few other insects closely allied to it. Its cultivation is an ancient industry in China and has spread from there to other countries, particularly Japan, Asia Minor and the southern countries of Europe, where the climate is favorable to the growth of the mulberry tree, whose leaves nourish the worms. In spite of a suitable climate in parts of the United States and repeated efforts aided by the government, the cultivation of the silkworm has never been a success in this country, as it depends on a plentiful supply of cheap labor. Chemically, silk fiber consists of a core of fibroin ($C_{15}H_{26}N_5O_6$), which constitutes 75 to 82 per cent of the entire mass, a covering of sericin or silk albumen ($C_{15}H_{25}N_5O_8$) and a little waxy and coloring matter. Fibroin is soluble in strong alkalis, concentrated sulphuric and nitric acids, concentrated zinc chloride solutions, ammoniacal solutions of copper oxide and nickel oxide. Its solubility in ammoniacal nickel oxide distinguishes it from cotton and artificial silk. Sericin is soluble in hot water and warm soap solutions. Silk is quite hygroscopic, containing under normal atmospheric conditions about 11 per cent of moisture.

Artificial silk is chemically quite different from the natural product. It is a derivative of cellulose and resembles silk only in certain physical characteristics, particularly the luster. At the most, it contains only traces of nitrogen.

At the present time there are four types of artificial silk manufactured commercially: Nitrocellulose silk (Chardonnet, Lehner or Tubize silk). Cuprammonia silk (Despaissis or Pauly silk, Glanzstoff). Viscose silk. Cellulose acetate silk. The first three are hydrated forms of cellulose, whereas the last named is, as its name implies, an ester of cellulose.

History of Artificial Silk

The first hint as to how silk might be imitated was given by Réaumur, the French scientist, who as early as 1734 suggested the drawing of threads from the gums and resins used in the manufacture of Chinese varnish[1]. It was more than 120 years later, however, before his suggestion bore fruit, when Andemars of Lausanne obtained a patent (Br. Pat. 283; 1855), according to which he made a collodion from the bast fibers of young mulberry twigs and mixed it with a solution of one part of rubber in ten parts of ether. Into this mixture he dipped a steel point and by means of it drew out a thread

which was reeled in the usual way. Two years later Hughes (Br. Pat. 67; 1857) mentioned a viscous mass consisting of glue, starch, resins, etc., which he proposed to spin like glass. Ozanam was the first to suggest spinning through fine openings (spinnerets) in imitation of the silkworm[2]. In 1883 Joseph Wilson Swan of Bromley, England, produced filaments for use in incandescent lamps by extruding a nitrocellulose solution through fine openings into 70 to 80 per cent alcohol (Br. Pat. 5,978; 1883) and denitrating them by means of ammonium sulphide or other reducing agents[3]. It will be noted that Swan's method foreshadowed the essential steps of the process that first produced commercially successful artificial silk[4].

Outline of Process

In principle, the manufacture of artificial silk consists in dissolving cellulose, or one of its derivatives, in suitable solvents, and coagulating the solution, as it is extruded through fine openings, by removal or dilution of the solvent, or by decomposition of the soluble cellulose compound. This may be followed by further treatments to regenerate cellulose, as in nitrocellulose silk. The first method of coagulation is used in nitrocellulose and acetate, the second in cuprammonia and viscose silks.

The usual sources of cellulose are chemical woodpulp and cotton linters. The former is used only for the viscose process, and even there the cheapness of linters and the more uniform quality obtainable has caused manufacturers, in this country at least, to abandon woodpulp almost entirely. No matter what the source or the later process used, the first essential is a proper purification of the cellulose. It must be freed from impurities, such as grease, mineral matter, pectic substances, etc. Woodpulp in the form obtained from Norwegian spruce by the sulphide process answers these requirements sufficiently for the viscose process. Cotton linters (the short fibers remaining on the cotton seed after ginning) are boiled under a pressure of several atmospheres in a weak solution of caustic soda to which sometimes a little resin soap is added. After careful washing to remove and recover the caustic soda, the linters are lightly bleached with chloride of lime, washed again to remove all traces of chlorine and lime, and dried.

The spinning solutions must be of such character that they can be drawn out to a long fine thread which can easily be coagulated and which will have a certain elasticity and strength so that it will not break in spinning. They must necessarily be free from air, dust and other impurities that would cause uneven or defective threads. In general, the aim is to have a spinning solution that is practically on the point of precipitation

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[1] "Mémoire pour servir à l'histoire des insectes," vol. 1, p. 154.

[2] *Compt. rend.*, vol. 55, p. 883 (1862).

[3] According to Lehner (*Chem. Zeit.*, p. 579, 1906) cloth made from Swan's filaments was shown at a London exhibition in 1884. A paragraph in *J. Soc. Chem. Ind.*, p. 34, 1885, mentions the product under the name of artificial silk.

[4] Similar methods, some depending on solutions of cellulose in zinc chloride, were patented in England in 1884 by Swinburne (Br. Pat. 4,121), Evans and Wynne (Br. Pat. 12,675), Watt (Br. Pat. 13,133), Wynne and Powell (Br. Pat. 16,805).

so that the thread will coagulate immediately on coming in contact with the precipitant. The viscosity is influenced by the preliminary treatment of the cellulose, the composition of the solvent and the temperature. Except in the case of nitrocellulose, the spinning liquids deteriorate on standing, especially at higher temperatures, and therefore it is usual to keep and "age" them in cold rooms that are maintained at temperatures of 4 deg. C. or lower.

The spinning apparatus consists essentially of a distributing pipe to which are attached branches carrying the individual spinnerets; a trough containing the precipitating bath into which dip the ends of the spinnerets, and a rotating receiver for the spun filaments. This receiver may be either a glass cylinder upon which the threads are wound crosswise, or a can in which the thread is deposited in skein form by centrifugal force. The spinnerets are usually made of glass connected individually to the distributing pipe, or combined in the form of a spray so that each spray furnishes the number of filaments required for one thread. The thickness of the filament is a function of the size of the spinning opening, the concentration and viscosity of the solution and the ratio of the spinning pressure to the speed with which the filament is drawn off.

CHARDONNET PROCESS

The first commercial process owes its development and practical application to the French Count Hilaire de Chardonnet, who was granted his first patent (French 165,349) in 1884. His first product was undenitrated nitrocellulose. This proved too flammable and it became necessary to remedy this defect by denitration. Chardonnet established a factory in Besançon, France, which in 1891 had a production of 100 lb. daily. By 1907 this rate had been increased to about 4,000 lb. per day. Other plants were started in Switzerland, Germany, Belgium, Hungary, Italy and England; but the last named was in existence only a short time.

Chardonnet worked with concentrated solutions of nitrocellulose (20 to 25 per cent) in a mixture of ether and alcohol which necessitated the use of relatively high pressures (40 atmospheres) and very fine spinning jets (0.08 mm.). Lehner modified this procedure by using thinner solutions (10 to 15 per cent), sometimes reducing the viscosity further by addition of acids. This made it possible for him to use much lower pressures. By drawing his filaments fine during their passage through the coagulating bath he was able to increase the size of his spinnerets still further to about 0.5 mm.

Another difference between the two methods existed in the manner of coagulation. Chardonnet's concentrated solutions made from nitrocellulose containing about 20 per cent of water harden sufficiently on exposure to moist air to be wound on bobbins without sticking and can therefore be spun "dry." Lehner spun his silk "wet"—that is, the ends of the spinnerets were immersed in water or weak alcohol, and the filaments coagulating slowly in this liquid were drawn out by winding them on cylinders at a greater speed than that with which the solution issued from the jets.

NITROCELLULOSE SILK

properly purified cotton is dried to a moisture content
In the manufacture of the nitrocellulose itself, the of about 0.5 per cent, and nitrated at temperatures from 40 to 50 deg. C. in an acid mixture containing about 31 per cent of nitric and 54 per cent of sulphuric acid. Nitration is generally carried on in some form of mechanical dipping device[5]. After removal of the excess acid by centrifuging, the nitrocellulose is purified by boiling, pulping and washing in pure water. It is then freed from excess of water by centrifuging and sometimes further dried by displacing the water by alcohol. The solution of the nitrocellulose in the ether-alcohol mixture is carefully filtered under pressure to remove all undissolved particles and permitted to stand for several days to free it from air bubbles, which would cause weak spots or breaks in spinning. Storing the solutions in large tanks also has a blending effect and tends to make the product more uniform.

Generally sixteen to eighteen filaments are united to form one thread and given a slight twist on machines similar to those used in the twisting of natural silk in order to hold them together. From the twisting machines the threads are reeled in the form of skeins and then treated with sodium sulphhydrate to remove the nitric acid with which the cellulose had been combined. They are now washed with water, treated with hot dilute hydrochloric acid to remove iron sulphide, washed, bleached with sodium hypochlorite, washed again, sometimes passed through a soap solution to soften them, and dried.

The air from the spinning room is passed through scrubbing towers, where the alcohol is absorbed in water and the ether in sulphuric acid. The solvents are recovered from the absorption liquids, as well as from the precipitating bath, by distillation.

The advantages of the nitrocellulose process are primarily that the solution used is stable and may be kept for a long time without deterioration, and further that the mechanical processes of washing, twisting and reeling are carried on while the threads are in the thick and strong form of nitrocellulose. It has, however, many disadvantages. Nitrocellulose is highly flammable and care must be taken to keep it wet at all times. The solvents for it are expensive, volatile, flammable, and form explosive mixtures with air. Their recovery presents difficulties[6]. Expensive nitric acid is used to make nitrocellulose and must be removed without the possibility of recovering it. On denitration, the filament loses strength and weight, so in this respect it has no advantages over other forms of artificial silk.

CUPRAMMONIA PROCESS

The next process to find commercial application is based on the solubility of cellulose in an ammoniacal solution of copper hydroxide (Schweizer's reagent). This method is due to Louis Henri Despaissis, who was granted a patent in 1890 (French Pat. 203,741). Owing to a peculiarity of French law, the patent lapsed on the death of the inventor, which occurred a short time thereafter. In 1897 Hermann Pauly was granted German patent 98,642 (U. S. 617,009) which forms the basis of all subsequent methods. Manufacture was promptly undertaken by the Vereinigte Glanzstoffabriken A. G. in Elberfeld with factories at Oberbruch and Mulhouse, and further development is largely due to Bronnert, Fremery and Urban of this company.

The cellulose solvent may be prepared by precipitating copper hydroxide from copper sulphate solution with sodium hydroxide, washing the precipitate care-

[5]*Chem. & Met. Eng.*, vol. 26, p. 281 (1921).
[6]The alcohol consumption in the Chardonnet plant in 1907 is said to have been 4 to 5 liters per pound of artificial silk.

fully and dissolving it in aqueous ammonia. The method of the Glanzstoff A. G. consists, however, in the oxidation of metallic copper in the presence of ammonia. A tower is filled with copper clippings and 14 per cent ammonia water. Air is blown in at the bottom of the tower, the whole system being maintained at a temperature of 0 to 5 deg. C. After about a day solution is complete and the liquid contains up to 5 per cent copper. It must be kept at a low temperature, as otherwise copper is precipitated. Purified cotton is dissolved in this solution. The spinning liquid contains 7 to 8 per cent cellulose, 2.5 to 3 per cent copper, and 7 to 8 per cent ammonia. A small quantity of cane sugar is also added. Its viscosity should be such that the time required for 150 c.c. to flow through a short orifice 5 mm. wide from a tube 32 mm. wide and 280 mm. long, provided with two marks indicating a volume of 150 c.c., will be 5 to 6 minutes. The solution should also be capable of forming a continuous thread, 2 meters long, before breaking up into drops. This solution is passed through three filter presses in succession, the first being equipped with metal cloth having 1,200 meshes per sq.cm., the second 1,400 and the third 1,500 meshes. It is finally filtered through asbestos cloth.

The glass capillaries used for spinning have an internal diameter of 0.16 to 0.20 mm. and are 2.5 to 4 mm. long. A spinning pressure of 1.5 to 2.5 atmospheres is used. Originally the precipitating liquid was 50 per cent sulphuric acid and the filament was washed on glass cylinders with a weak solution of ammonium acetate, followed by treatment with ammonia-soap solution at 50 deg. C. This method has since been superseded by alkaline precipitation. The bath contains 25 to 33 grams of caustic soda and 8 grams of glucose per 100 c.c. and is maintained at 48 to 50 deg. C. The threads are wound on glass cylinders, washed in water, passed through a bath containing magnesium or aluminum sulphate to displace the alkali, washed again and dried. The filaments making up one thread are now twisted with three turns to the inch and reeled. They still contain copper, and this is removed by washing the skeins in weak acid. After washing to remove the acid, the skeins are soaped and finally dried. Alkaline spinning gives a stronger and better thread.

The Thiele-Bemberg method is a modification of the one just described in so far as the spinning process is concerned. Instead of a fine capillary, spinning jets having an internal diameter of 0.8 mm. and a weak alkaline precipitant (2 per cent NaOH) are used. The filaments drop through a 50-cm. column of this liquid, which has a slow coagulating action, and are drawn out to very fine diameters by their own weight. It is said that dry diameters of 0.015 mm. may be thus obtained[7].

VISCOSE PROCESS

Viscose silk, at this time probably the most important of the artificial silks, owes its origin to the work of Cross, Bevan and Beadle, who obtained a patent (Br. Pat. 8,700; 1892) for the preparation of a water soluble derivative of cellulose which they called viscoid or viscose. Stearn made this product available for the manufacture of filaments by patenting various precipitating agents (U. S. Pats. 622,087; 716,778; 725,016). Müller (U. S. Pat. 836,452) protected the present method of using a bath containing sulphuric acid and a sulphate.

The cellulose, whether woodpulp or linters, is trans-formed into its sodium compound by grinding with three times its weight of 17 to 18 per cent caustic soda in a wheel mill, and storing it in boxes for 48 to 72 hours. The same effect is obtained by mixing it with ten times its weight of the same strength caustic in a Werner & Pfleiderer mixer, permitting it to stand for 24 hours, and then centrifuging until the liquid content has been reduced to the same weight as in the previous method. It is then permitted to stand 48 hours more. To 400 parts of this mass (containing 100 parts of cellulose) in a rotating cylindrical mixer are added 60 parts of carbon bisulphide, and the mixing is continued for 1 to 3 hours at 15 to 30 deg. C. The excess of carbon bisulphide is then evaporated. The viscous mass is now dissolved in 54 parts of caustic soda and 300 parts of water in a W. & P. mixer and diluted until it contains 9 to 10 per cent of cellulose. The viscosity of the solution depends on the treatment of the raw cellulose as well as on the length of the alkali treatment. The solution is now filtered through cotton batting held between cotton cloths and permitted to age or mature at a temperature below 10 deg. C. until a sample gives an insoluble thread in 5 per cent formic acid. Originally the thread was coagulated by means of acid or ammonium salts. In present practice the bath is made up of 40 parts sodium bisulphate, 7 parts sulphuric acid and 60 parts water. The thread, made up of a number of filaments, may be crosswound on bobbins and washed and dried in this form. More frequently it is collected in the rotating cans previously mentioned (U. S. Pat. 702,382), washed in the form of skeins and dried under tension on reels[8].

CELLULOSE ACETATE

Cellulose acetate silks are of more recent development. Mork, Little and Walker were among the first to patent their production (U. S. Pats. 712,200 and 792,149). Dried cotton linters are treated for several hours, gradually increasing the temperature from 15 to 40 deg. C., with 25 per cent acetic anhydride, to which about 1 per cent of sulphuric acid has been added. At the end of this time the mixture is diluted with 50 per cent acetic acid containing some sulphuric acid, and hydrolyzed for 3 hours at temperatures ranging from 25 to 70 deg. C. Cold water is then added to precipitate cellulose acetate, which is filtered off and washed free from acid. For the production of filaments the acetate is dissolved in a suitable solvent, such as glacial acetic or formic acid, chloroform, acetylene tetrachloride, and spun in a manner similar to those described into a precipitating bath. This bath may be water, if the solvent is miscible with water; or alcohol, benzene, etc., if it is not. The solvent and precipitant must be chosen in such a way that one will easily mix with the other and that the solvent will readily diffuse through the thin filament walls of the precipitated cellulose acetate.

Acetate silks are decidedly stronger than the other silks when wet. They have a very low electric conductivity and may displace natural silk entirely for insulating wires, etc. They cannot be dyed in the same manner as the other silks, but methods have been found to overcome the dyeing difficulties[9].

OTHER PROCESSES

Various other processes of artificial silk manufacture have been proposed at one time or another, but have

[7]Ost. *Z. angew. Chem.*, vol. 31, p. 141 (1918).

[8]Wilson, *J. Soc. Chem. Ind.*, vol. 36, p. 817 (1917).
[9]*J. Soc. Dyers & Colour.*, vol. 38, p. 162 (1922).

not been successful, although some of them have found temporary use. We merely mention gelatine (Vanduara silk), albumin, casein, macerated silkworms, natural silk solutions, solutions of cellulose in caustic soda, various acids and zinc chloride (filaments for incandescent carbon lamps).

Brief mention may be made of the manufacture of allied products, such as artificial horsehair, imitation fabrics, etc. For horsehair the solution of cellulose is spun through large openings and dried under small tension to get away from the too brilliant luster of silk, or the hair may receive a later treatment with oils. Artificial lace and tulle are made by passing a very viscous solution through engraved rolls into a precipitating bath. Remarkable effects can be obtained in this way. During the war Germany produced considerable quantities of so-called *Stapelfaser*, which was used as a substitute or admixture for wool. This is made by twisting artificial silk in the usual way, then cutting it into short lengths and spinning the resulting fibers, either alone or mixed with wool, just as cotton or wool is spun.

PROPERTIES

The specific gravity of artificial silk is about 1.51 whereas that of natural silk is only 1.36. Its moisture content under normal air dry conditions is about the same as for silk—i. e., 11 per cent. Acetate silk, however, under the same conditions contains only 2 to 3.5 per cent moisture. The diameters, according to Massot, compare as follows[16]:

Natural silk ....0.0150 mm.
Chardonnet silk...................0.0288 mm.
Lehner silk ....0.0354 mm.
Glanzstoff ....0.0295 mm.
Viscose silk ....0.0305 mm.

Artificial silks swell when moistened, and in this condition the diameters are from 50 to 60 per cent larger. Advances in the art since the time of Massot's publication have made it possible to obtain much finer threads, closely approaching natural silk, as in the Thiele process previously mentioned and in Bronnert's work on viscose (U. S. Pats. 1,374,718; 1,376,671-2; 1,393,197-8-9).[11]

According to Strehlenert[17], the strengths of various natural and artificial silks compare as in Table I.

S. J. Pentecost[19] gives the figures of Table II.

TABLE I—STRENGTH OF SILKS

Variety	Strength, Kg. per Sq.Mm.	
Natural silks	Dry	Wet
Chinese	53.2	46.7
French	50.4	40.9
French boiled off	25.5	13.6
French dyed red and weighted	20.0	15.6
French blue black, 100 per cent weighting	12.1	8.0
French black, 140 per cent weighting	7.9	6.3
French black, 500 per cent weighting	2.2	....
Artificial silks		
Chardonnet nitrocellulose	14.7	1.7
Lehner nitrocellulose	17.1	4.3
Strehlenert nitrocellulose	15.9	3.6
Glanzstoff	19.1	3.2
Viscose, Cross and Bevan	11.4	3.5
Viscose, latest	21.5	....
Cotton yarn	11.5	18.6

TABLE II—STRENGTH BY DENIERS

Type	Size in Deniers[14]	Strength, Kg. per Sq. Mm.		
		Dry	Wet	Redried
Chardonnet	120	42	0	95
Glanzstoff	130	40	35	41
Viscose	120	51	50	51.5
Viscose	200	91	86	88

[10]*Leips. Mon. Text. Ind.*, 1902, pp. 760 and 832; 1905, p. 131.
[11]*J. Soc. Dyers & Colour.*, vol. 38, p. 153 (1922).
[12]*Oest, Chem. Zeit.*, p. 297, 1900.
[13]*J. Soc. Chem. Ind.*, vol. 35, p. 587 (1916).
[14]In the trade, the fineness or "count" of silk is given in deniers, which is the weight, expressed in grams, of a thread 9,000 meters (Italian legal denier) or 10,000 meters (metric denier) long.

It will be noted that in Strehlenert's figures the artificial silks compare favorably with dyed silks, especially if the latter have been weighted to any extent. Here again, numerous advances have been made and the strengths of artificial silks have been improved.

DISTINGUISHING SILKS

Methods of distinguishing between the various kinds of artificial silks are given by Maschner[15]. About 0.2 gram of the sample in a test tube is covered with concentrated sulphuric acid. Copper silk turns yellow at once, changing in a few minutes to a yellowish red. Within half an hour it dissolves, coloring the acid a pale yellowish brown. Viscose silk turns to reddish brown in 1 or 2 minutes and dissolves to a brown liquid. Concentrated phosphoric acid of 1.7 sp.gr. turns copper silk that has been spun in alkali, brown, whereas it gives no coloration with copper silk spun in acid, nitrocellulose or viscose silks. Known samples should be subjected to these tests at the same time as the unknown to make sure of the colors. Nitrocellulose silk, owing to traces of undecomposed nitric acid esters which are always present, gives a dark blue coloration with a solution of diphenylamine in concentrated sulphuric acid.

Comparison of the cross-sections under the microscope is probably the best method for distinguishing between natural and artificial silks. A rough test that may, however, be masked by dyeing is to burn a thread of each. Silk will give the characteristic odor of burning nitrogenous matter. According to Formhals[16], the samples to be tested are dissolved in concentrated sulphuric acid, diluted with water and then made alkaline. A solution of diazotized paranitraniline is now added. Natural silk under these conditions will give a red, artificial silk a yellow color. It is claimed that this test may be used successfully even in the case of heavily weighted, dyed silks.

It would lead too far to go into the dyeing of artificial silk. Suffice it to say that in general it has a greater affinity for dyestuffs than cotton. This does not apply to acetate silk, where special methods have to be used to fix the dyestuffs on the fiber. Specific instructions for the different cases may be obtained from the dye manufacturers.

USES OF ARTIFICIAL SILK AND ITS CONSUMPTION IN THE UNITED STATES

Since artificial silk first came on the market its uses have rapidly increased. It has been improved to such an extent that it can be used in a great many cases in place of silk. Where there is considerable strain on the fabric, it is generally woven or knitted with a thread of silk or cotton. The largely increased production of artificial silk has apparently had no influence on the consumption of the natural product. Artificial silk must be considered as a new textile material rather than as a substitute for an old one; it has made a place for itself in many fields, and there is ample room for both. In 1899 the consumption of artificial silk in the textile mills of the United States amounted to 6,056 lb., of a value of $10,380. Table III shows how it has grown in importance since that time.

Wilson[17] estimates the present daily production of

[15]*Lehne's Färberztg.*, vol. 21, p. 352 (1910).
[16]*Lehne's Färberztg.*, p. 6, 1913.
[17]*J. Soc. Chem. Ind.*, vol. 39, p. 266 R (1920).

TABLE III—SILK CONSUMPTION IN UNITED STATES

Year	Raw Silk (a) Imports, Lb.	Artificial Silk Imports (b), Lb.	Artificial Silk U.S. Manufacture (b), Lb.	Average Value Per Lb.
1899	11,250,383	....	6,056 (c)	$1.72
1904	16,722,709	....	466,151 (c)	3.52
1909	25,187,957	....	914,494 (c)	2.13
1912	26,584,962	1,631,807	1,117,285	....
1913	32,101,555	1,395,599 (f)	1,565,583	....
1914	34,545,829	2,590,490 (f)	2,443,954	1.83
1915	31,052,674	3,044,316	4,107,385	2.46
1916	41,925,297	973,082	5,741,338	3.12
1917	40,351,423	543,446	6,696,861	3.52
1918	43,680,988	120,540	5,827,627	4.50
1919	44,816,918	1,072,040	8,173,824	5.50 (d)
1920	30,050,374	1,846,875 (e)	....	....

(a) Statistical Abstract of the U. S.
(b) *Chem. Age* (N. Y.), vol. 26, p. 147 (1920).
(c) Consumption in textile mills of U. S. (Census of Manufactures, 1914).
(d) $4.25 low; $8 high.
(e) Foreign Commerce and Navigation of U. S., 1920.
(f) Up to 1912 artificial silk imports were included with silk figures.

artificial silk to be from 5 to 6 tons in Germany, 4 tons in France, 10 tons in England, with smaller quantities produced in Belgium, Switzerland and Italy. The estimate for Germany is believed to be low. The capacity in this country is probably about 45,000 lb. daily for viscose and 7,000 lb. for nitrocellulose silk.

PROCESSES USED IN DIFFERENT COUNTRIES

It is interesting to note that nitrocellulose silk, which had its origin in France, has been most successful there and in Belgium. Cuprammonia silk, developed largely in Germany, has had its greatest success in that country, although the branches of the Glanzstoff A. G. have prospered in other countries. England and the United States have more or less confined themselves to viscose, which was discovered by Englishmen. The German viscose plants of Count Donnersmarck have never been successful and were sold to the Glanzstoff people a few years before the war. Owing to the scarcity of cotton, copper and ammonia during the war in Germany, the Germans turned to the manufacture of viscose silk in spite of the success they had previously had with cuprammonia. Of the nitrocellulose factories, the Belgian plant at Tubize has been signally successful, owing perhaps to a favorable and cheap supply of alcohol. Foltzer, in his book on "Artificial Silk and Its Manufacture," gives the following comparative cost figures for artificial silk:

    Nitrocellulose ..13.55 fr. = $2.61 (at par of exchange)
    Cuprammonia .. 8.85 fr. = $1.71
    Viscose .... 8.25 fr. = $1.59

Solvents recovery has since been improved so that at this time the cost of nitrocellulose silks is relatively lower.

In the United States today three processes are in use—viscose, nitrocellulose and acetate. Of these viscose is the oldest, having been started in Lansdowne, Pa. (later Marcus Hook, Pa.), in the early years of this century. The nitrocellulose plant is the youngest, having been built in 1921. Cellulose acetate still seems to be in the experimental stage and but little of it is on the market. Cuprammonia has never established a foothold here, though a number of small plants have been started from time to time for its production. The failures seem to have been due to lack of capital or inexperience in the mechanical handling of the product. On the other hand, this type has been very successful in Germany and other places where the original manufacturers established branches and large

quantities were imported and used here before the war. There seems to be no reason why it should not be made successfully in this country, as the raw materials—cotton, copper and ammonia—are available in large quantities and at prices as low as or lower than elsewhere. With an efficient recovery, it is decidedly cheaper to manufacture than nitrocellulose silk and should cost little if any more than viscose silk. It has a higher luster than either and has no tendency to yellow or deteriorate in storage.

The artificial silk industry is one of the few that have suffered little from the business depression prevailing during the past 2 years, and promises to maintain its status as an important branch of the textile and chemical industries.

U. S. PATENTS RELATING TO ARTIFICIAL SILK

NITROCELLULOSE SILK

365,832	516,079	573,132	834,460	1,093,012
367,534	516,080	593,106	842,125	1,127,871
430,508	531,158	663,739	866,768	1,151,487
439,882	559,392	665,975	888,260	1,188,718
455,245	562,626	699,155	951,067	1,236,719
460,629	562,732	820,351	1,022,416	1,315,700
508,124	563,214	828,155	1,040,886	1,315,701

CUPRAMMONIA SILK

617,009	779,175	852,126	960,791	1,000,827
646,351	795,526	857,640	962,769	1,022,097
646,381	798,868	863,801	962,770	1,023,548
650,715	806,533	863,802	965,273	1,027,689
657,818	813,878	866,371	965,557	1,030,251
658,632	836,620	879,416	967,397	1,034,235
661,214	839,013	884,298	977,863	1,049,201
672,350	839,014	904,684	978,878	1,062,106
672,946	839,825	908,754	979,013	1,062,222
691,257	840,611	909,257	980,294	1,064,260
698,254	842,568	945,559	983,139	1,066,785
705,748	850,571	947,715	986,017	1,106,077
710,819	850,695	954,984	988,430	1,130,830
		957,460		

VISCOSE SILK

622,087	808,148	984,539	1,143,569	1,376,671
716,778	808,149	986,306	1,200,774	1,376,672
724,020	816,404	1,044,434	1,226,178	1,375,823
725,016	836,452	1,045,731	1,280,338	1,375,824
759,332	849,823	1,073,891	1,292,544	1,387,882
747,421	863,793	1,102,237	1,355,985	1,398,525
773,412	896,715	1,117,604	1,379,351	1,393,197
792,888	950,435	1,119,155	1,374,718	1,393,198
798,027	970,589	1,121,605	1,366,162	1,393,199
805,456	980,648	1,121,903	1,366,163	1,401,943

CELLULOSE ESTERS

712,200	838,350	955,082	988,965	1,107,222
733,729	902,093	972,464	1,028,748	1,109,512
792,149	912,637	981,574	1,055,513	1,156,969
	922,340		1,074,092	

ARTIFICIAL HORSEHAIR, ETC.

680,719	791,385	804,191	856,857	1,128,624
713,999	791,386	853,093	1,010,222	1,164,084

APPARATUS

702,163	750,502	846,879	923,777	1,155,777
702,382	796,740	849,822	979,434	1,184,206
716,138	823,009	849,870	988,424	1,202,766
732,784	827,434	858,648	1,093,146	1,366,166
745,276	838,758	876,533	1,119,155	1,371,113

MISCELLANEOUS PATENTS RELATING TO OTHER FORMS OF ARTIFICIAL SILK, SOLVENTS, DYEING, ETC.

571,530	646,799	961,241	1,082,490	1,315,393
594,888	697,580	979,966	1,087,700	1,366,023
611,814	712,756	995,652	1,141,510	1,378,443
625,033	729,749	1,002,408	1,169,267	1,398,357
625,345	836,788	1,041,587	1,218,954	1,394,270
	932,634		1,242,030	

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Thermal Conductivity of Refractories*

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IN CONNECTION with the work of A.S.T.M. committee C-8 on refractories, and particularly with that of the sub-committee on thermal conductivity, it seems worth while to consider, briefly, the relation of thermal conductivity to other properties of refractories and to attempt to find what place, if any, this property will have in specifications for refractories. It may also be worth while to try to determine what is most needed in the way of data and of methods of test.

Factors of Importance in Refractory Specifications

In practically all the uses to which refractories are put, the most essential requirement is that they shall resist destructive agencies, including heat, erosion, the chemical action of the constituents of furnace gases and the corrosive action of slags and glasses. No single type of material will resist all the destructive agencies successfully; neither are all the destructive agencies found in any one furnace. The primary purpose of a specification is to state, quantitatively, the properties which a refractory material must have in order to resist, for a reasonable length of time, the destructive agencies which will be encountered in a specific place in a particular type of furnace.

In general, only one type of refractory material is suitable for a given purpose. Most of the high-temperature furnace work calls for high-grade fireclay brick; for certain conditions, silica refractories are practically always used, and other conditions require still other types. It has been sufficiently well established that the difference in thermal conductivity between different brands or grades of brick within a given type or class are not important as compared with differences in refractoriness, in resistance to spalling, resistance to slag corrosion, etc. It seems probable, therefore, that in the great majority of cases those properties which are essential to resistance to destructive agencies and which vary to an important extent from one brand of brick to another will be made the matters of specification regardless of thermal conductivity.

There are cases, however, in which the selection of the *type* of refractory to be used for a given purpose is influenced by the relative conductivities of different types, and in cases of this sort, where more than one type is available and the conductivity is especially important, heat conductivity may eventually become a matter of specification.

Reliability of Available Thermal Conductivity Data

Since thermal conductivity may be a factor in the selection of the type of brick to be used for a given purpose, it is important to have reliable data as to the conductivity of the different refractory materials and it may be worth while to consider the completeness and the reliability of the figures now available.

Unfortunately, the figures given in many of the tables to be found in handbooks and elsewhere have been taken from unsatisfactory sources and are somewhat con-

fusing. This applies particularly to the data obtained from the investigation by Wologdine,[1] which were for a number of years (1909-1915) the best data available on the heat conductivity of refractory materials and have, in consequence, been very extensively quoted. However, it is difficult, in going over Wologdine's results, to find record of a single group of specimens that appears to have been burned to the temperature to which the material would have been burned commercially; it appears to have been the purpose of the investigator to show the effect of the temperature of burning on the conductivity of the various materials rather than to provide data for the use of engineers and others who might have occasion to estimate heat losses in connection with the design of furnace installations.

In 1915 important work on thermal conductivity of refractories was reported by one American[2] and a group of British[3] investigators. The work of Dudley has much to recommend it. His determinations were made on large specimens built up from several full-size bricks and he used well-known American brands of firebrick, thereby establishing the identity of the materials on which his conductivity determinations were made. His description of his method indicates that his work was done with what may be termed good engineering accuracy.

The work done by Dougill, Hodsman and Cobb appears to have been well planned and skillfully executed. Their method permitted the use of commercial bricks, made and burned in the regular way. While their determinations were not made on the same brands of brick as Dudley's, they included approximately the same classes of refractories that he tested and a comparison of those results which are comparable, from

[1]Bull. Soc. d'Encour., p. 879 (1909) ; *J. Soc. Chem. Ind.* (1909).
[2]"The Thermal Conductivity of Refractories," by Boyd Dudley, Jr., *Trans., Am. Electrochem. Soc.*, vol. 27, p. 285 (1915).
[3]"The Thermal Conductivity of Refractory Materials," by C. Dougill, H. J. Hodsman and J. W. Cobb, *J. Soc. Chem., Ind.*, vol. 34 (1915).

TABLE I

Class of Refractory	Investigator	Brand or Make	Inner Surface	Outer Surface	Mean Thermal Conductivity, *k**	Remarks
Fireclay	A	Woodland	965	120	0.0026	
		Woodland	1,025	100	0.0026	
		Woodland	995	400	0.0027	
	B	Farnley	825	260	0.0029	
			970	300	0.0029	Hard fired—Seger cone
			1,080	330	0.0036	10-11 approximately
			1,440	550	0.0040	
			1,100	420	0.0033	
			1,350	510	0.0039	Another specimen
Siliceous Brick with clay bond	A	Quartzite	935	100	0.0026	
			960	100	0.0026	
	B	Farnley	1,300	310	0.0025	Many quartz grains
Silica brick	A	Star	910	100	0.0031	
	B	Gregory	995	295	0.0030	
			1,210	370	0.0035	Coarse grained
			1,240	440	0.0039	
			1,395	440	0.0042	
Magnesite brick	A		830	445	0.0135	
			875	525	0.0110	
			1,040	590	0.0098	
	B	Mabor	1,370	690	0.0091	

Temperature Range, Deg. C. (Inner Surface / Outer Surface)

* Cal. per sec. per sq.cm. for a temperature gradient of 1 deg. C. per cm.

A—"The Thermal Conductivity of Refractories," by Boyd Dudley, Jr., *Trans. Am. Electrochem. Soc.*, vol. 27, p 285 (1915)

B—"The Thermal Conductivity of Refractory Materials," by G. Dougill, H. J. Hodsman and J. W. Cobb—*J. Soc. Chem. Ind.*, vol. 34 (1915).

these two investigations, given in Table I, shows as close agreement as could be expected. While most of their results are expressed as the mean k for the specimen under the temperature conditions existing in it at the time the determination was made, both Dudley and Dougill, Hodsman and Cobb computed, from their data, the coefficients of thermal conductivity of some of the materials which they investigated, for different temperatures up to 1,000 deg. C. Dougill, Hodsman and Cobb deduced the following formulas:

(1) For fireclay brick,

$$k_t = 0.00155 + 0.25 \times 10^{-5}t$$

(2) For magnesia brick,

$$k_t = 0.0285 - 0.379 \times 10^{-4}t + 0.179 \times 10^{-7}t^2$$

in which k_t is the thermal conductivity at temperature t.

APPLICATION OF THE DATA IN CALCULATING HEAT TRANSFER

All things considered, it seems entirely reasonable to accept results of these investigations and to make use of the formulas of Dougill, Hodsman and Cobb in ordinary engineering computations, making allowance for the fact that the values will be lower in the case of porous, light-burned brick and higher with denser brick. It is true that only rough estimates can be obtained in this way, but it must be taken into consideration that only rough estimates of the heat transfer through the walls of a given installation could be obtained by computation, in most cases, even though precise figures for the thermal conductivity of the firebrick were available. In the first place the temperatures of the inner and outer surface must be known and if the wall is to be more than one brick thick, the effect of the joint, or joints, must also be known as well as the conductivity of the refractory material, before the heat flow through the wall can be computed. Unless the temperatures of the two surfaces can actually be measured, a rough approximation is introduced at this point. The effect of joints must not be overlooked and introduces another factor that is uncertain as to magnitude.

EFFECT OF OTHER FACTORS—SURFACE RESISTANCE

Furthermore, it must be taken into consideration that heat conductivity, or its reciprocal, resistance to heat flow, is but one of several factors, working in series and that the larger the other factors, such as surface resistance and the effects of joints, the smaller, relatively, is the effect of differences or errors in the values assumed for thermal conductivity. The effect of surface resistance is shown in the operation of retorts, in a gas plant, by the fact that when the flame changes from transparent to luminous the rate of gas production increases, showing that heat is passing into the retorts more rapidly. When the flame is transparent a very large portion of the heat must be taken up by the retort by conduction; when the flame becomes luminous, radiant energy is transferred rapidly from the myriad of minute particles of incandescent carbon floating in the gas to the surface of the retort, and the retort is heated by radiation, reducing to a large extent, the effect of the surface resistance at the outer surface. The fact that the difference in rate of production is considerable shows that the surface resistance is a large factor. This factor has been studied sufficiently to justify the statement that the surface resistance of one surface of a retort may be as great as the internal resistance of the wall itself.

There is one other factor that should not be lost sight of in this connection. In the case of furnaces operating at high temperatures, there is a tendency for a portion of the brick to vitrify, in course of time, increasing the conductivity of that portion by possibly 40 to 50 per cent. Also, under certain conditions, refractories become impregnated with various substances taken up from the gases penetrating them and it is practically certain that the impregnated materials differ to an important extent in heat conductivity and in other properties from the original material.

It is not the purpose of the foregoing discussion to discourage the making of computations, but it is thought that some computers may believe, erroneously, that the lack of reliable figures for thermal conductivity is the greatest obstacle in the way of obtaining reliable estimates of the heat transfer to be expected in a given case, whereas, as a matter of fact, the more one studies the problem the less concern is felt about the accuracy of the value ascribed to the conductivity of the material in question; other factors which necessarily enter into the computation have to be approximated so roughly that the uncertainty involved in this one becomes relatively unimportant.

NEED FOR SIMPLE STANDARD METHOD

The fact remains, however, that in certain places, particularly in muffles and retorts, high conductivity is important because it is essential to efficiency, whereas in others, particularly in the insulating courses that are used in certain conditions, back of refractory linings, low conductivity is important for the same reason. With the advent of carborundum and other high conductivity refractories, as well as the introduction of new insulating materials, an increasing interest is being taken in the heat conductivity of refractories and it is important that a standard method for making conductivity determinations should be developed. The method should be simple so that routine tests can be made, with apparatus of moderate cost, with reasonable accuracy, by an operator of reasonable ability and experience. It would be a waste of time to make conductivity determinations with great precision on samples of firebrick, because the properties of different samples, even of brick of the same brand, would vary somewhat. On the other hand, it is essential that any method adopted be capable of giving results that can be depended on for reasonable accuracy, say to about 5 per cent.

In answer to the question which naturally arises, in this connection, as to what the Bureau of Standards is prepared to contribute in the way of a suggested method, it may be said that the bureau has been working for a number of years on the determination of thermal conductivity, the earlier work being done at low temperatures. Data obtained from this work are to be found in an article entitled "Thermal Conductivity of Heat Insulators," by M. S. VanDusen, in the *Journal* of the American Society of Refrigerating Engineers, November, 1920, and the *Journal* of the Society of Heating and Ventilating Engineers, October, 1920. Work is now nearing completion on a method for the accurate determination of the conductivity of refractory materials. While this method will not be adapted to the making of appropriate determinations in a routine way, it is believed that the knowledge and experience that have been gained in connection with the more

refined work that has been done will make it possible to develop a test method which will be suitable for such use.

SUMMARY

The situation in regard to heat conductivity may be summed up as follows: Differences in thermal conductivity between different brands or kinds of refractory materials within a given class, such as high-grade fireclay refractories, while they may be considerable, are comparatively unimportant so far as the efficiency of an installation is concerned, because the conductivity of the material constituting a wall is only one of several factors working in series, to affect rate of heat transmission. Thus a 10 per cent difference in conductivity may make only a 5 or a 2 per cent difference in the heat flow through a wall. On the other hand, the difference in conductivity between two types of materials such as fireclay refractories and carborundum refractories may be relatively important for such purposes as the walls of retorts and muffles. It is not unreasonable to expect that conductivity will become a matter of specification for refractory materials for certain purposes.

In regard to the question of obtaining satisfactory figures for use in computing heat flow through walls of various types in furnaces, attention is called to the fact that while the data of Wologdine, which have been copied extensively in physical tables, are likely to be misleading unless his work is discriminatingly studied, the data of Dudley and of Dougill, Hodsman and Cobb appear to be satisfactory for ordinary purposes. These investigators made determinations on well-known commercial materials and their results check as closely as should be expected, considering the fact that the materials studied were not identical. The data from these investigations should be satisfactory to the engineer, considering the fact that he must accept rough approximations for other factors involved in computations of heat transfer through walls.

The different investigators who have made heat conductivity measurements have developed a variety of methods, all of which are elaborate and laborious. There is a need for a standard method for making routine conductivity tests of commercial materials. It is not essential that it should be a precision method, but it is important that it be simple and reasonably convenient and at the same time accurate, within reasonable limits.

Hygroscopicity of Tetryl and Tetranitraniline

At the Pittsburgh, Pa., experiment station of the Bureau of Mines, a study is being made of the hygroscopicity of tetryl and tetranitraniline. The purpose of the investigation is to determine the physical constants of pure chemicals and the commercial products as used in the manufacture of explosives. The work is being done by L. G. Marsh, under the general supervision of C. A. Taylor, both assistant explosives chemists.

Chinese Pig Iron Production

Commercial Attaché Arnold, Peking, reports that, according to the estimate of K. Y. Kwong, Chinese engineer and mining authority, China's total production of pig iron annually is about 450,000 tons from Chinese furnaces and 250,000 tons from Japanese furnaces in China. The total output of iron ore in China is about 2,000,000 tons a year.

Industrial Ventilation as Applied To Dust and Fume Removal*

BY H. M. NICHOLS† AND F. R. ELLIS‡

TO QUOTE an official of one of the leading insurance companies: "Industrial or occupational diseases are becoming recognized more and more completely as being compensatable. That is to say, the insurance carriers (and therefore the employers, since they have to pay the insurance costs) now have to consider not only the obvious immediate injuries to employees from hazards such as burns from corrosive fumes or deaths from explosions of combustible dusts and vapors, but also the indirect and sometimes slow-acting internal injuries to employees, such as lead poisoning and other toxic actions in human organs and tissues."

It is, therefore, becoming a matter of economy as well as humanitarian to control these agencies so that they will not endanger the health of the workers, and mechanical ventilating systems play an important part in such control.

GENERAL METHOD OF ARRANGING MECHANICAL VENTILATION

The necessity for ameliorating the conditions created by machines producing irritating dust was recognized long before the days of liability insurance or of workmen's compensation legislation; in fact, the beginnings of the fan business were inspired by the necessity of finding some way to get rid of the irritating dust from buffing machines in the shoe industry. It was for this purpose that B. F. Sturtevant, the father of the industry, about 1860 conceived his first fan.

The treatment of this form of hazard—namely, all processes producing fine, irritating dusts from wheels or cutters—is today very much the same as the arrangement evolved in the application of this first fan. In this class come buffing, grinding and polishing wheel operation. Many classes of cutting operations may be treated in a similar manner.

INCLOSE WHEEL OF CUTTER AS COMPLETELY AS POSSIBLE

In general, the wheel or cutter is as nearly wholly inclosed as possible by a metal hood which is attached to and becomes a part of the piping of the exhaust system; the hood should be designed to take advantage of any movement given the dust by the operation. Thus, if a cutter throws the dust in a horizontal direction, the hood should be so arranged that the dust will be thrown into it. Where the material is thrown vertically upward or downward, the hood should be placed above or below the wheel or cutter. It is obvious that by carrying away the dust in the direction in which it is thrown the trapping and removal of the material will be the most effective.

It was only a small step from the removal of dust-buffing operations to the removal of refuse from woodworking machinery, and while many woodworking operations do not produce refuse in a finely divided state, the handling of this class of machinery is very similar to the method of handling buffing machinery.

Shrinkage and Expansion Of High-Speed Steel Due to Heat-Treatment

Volume and Hardness Changes, Thermal Analysis and Microstructure Indicate That Secondary Hardness in High-Speed Steel Is Due to Decomposition of a Stable Austenite Into Martensite II, Different From Martensite Formed During Quenching

By Marcus A. Grossmann

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TESTS described herein were recently undertaken primarily to obtain data on the amount which should be allowed in high-speed tools for shrinkage or expansion resulting from heat-treatment. The results obtained seem to throw an interesting sidelight on the nature of the reactions taking place during the heat-treating of high-speed steel.

Method of Testing

Tests were carried out on a high-speed steel of the following analysis: Carbon 0.65 per cent, tungsten 18.0, chromium 4.0, vanadium 1.0. Cylinders 1½ in. diameter and about 2½ in. long were heat-treated and the changes in length noted. In all the earlier tests the pieces were placed in a semi-muffle gas furnace without protection on the ends. Therefore, due to the formation of scale, no direct comparison of the annealed to the hardened state could be obtained. Instead, the scale was ground off and a measurement taken in the hardened condition; the pieces were then drawn at successively higher temperatures and measured after each draw. Finally the samples were annealed, oxidation being kept as low as possible. The final dimensions (after annealing) were assumed to be the same as those of an annealed piece before hardening. Later a method of clamping protecting pieces on the ends of the test-pieces was devised, which allowed the test-piece to be hardened at temperatures as high as 2,400 deg. F. without any visible oxidation. Measurements could then be taken directly on both the annealed and the hardened condition. All measurements were made with ordinary micrometers.

Heat-Treatment

In hardening, the test-pieces were preheated for about 15 minutes at about 1,550 deg. F. and were then heated to the temperature indicated on the graphs. In each case they were heated just to the temperature for quenching and then quenched in oil. The samples were measured as quenched and were then measured after each successive draw, each value shown in the table being an average of from four to six readings. Care was taken that the samples were measured always at the same temperature—about 70 deg. F. Drawings up to 600 deg. F. were done in oil; beyond that temperature the drawings were done in a lead bath covered with charcoal or in molten sodium-potassium nitrate. As soon as the specimen had been held the required time in the drawing bath it was immediately quenched in cold heavy oil in order to avoid excessive oxidation. It was not believed that this quenching had any effect on the dimensions inasmuch as the steel did not go through any transformations when being quenched from the drawing temperature, and the temperature gradient due to quenching could scarcely have been great enough to cause the steel at any point to exceed its elastic limit during the quenching. (For discussion of this point see Heyn, "Materialienkunde," Chap. VI, Section D.)

Observations

Examination of Fig. 1 shows that regardless of the quenching temperatures there is a certain regular trend of the contractions and expansions on reheating which in general vary in amplitude but not in direction. (It may be well to repeat here that all measurements were taken after the steel had cooled to room temperature, 70 deg. F. Therefore when, for example, a "contraction on heating" is mentioned, this refers to the comparative dimensions of the cold test-pieces after cooling from the heating temperature, and takes no account of the intervening normal thermal expansion in the heating process, which has no especial relation to the structural changes.) When the quenched steel was reheated slightly and then cooled, a contraction resulted; after further heating at higher temperature it showed a larger shrinkage until a drawing temperature of about 1,000 deg. F. was reached. Drawing to higher temperature (1,050 deg. F.) then caused an expansion which was only very moderate, but which became very marked after reheating to about 1,100 deg. Drawing beyond this temperature again caused a contraction, which continued until the steel was fully annealed.

Howard Scott[1] shows a figure giving practically the same shape curves as those shown in Fig. 1. After quenching at 1,940 deg. F. (1,060 deg. C.) his curve representing drawing temperature versus density shows uniform shrinkage after a draw up to 750 deg. F. and then a slight expansion after a draw at 1,100 deg. F.

It will be observed that as the quenching temperature
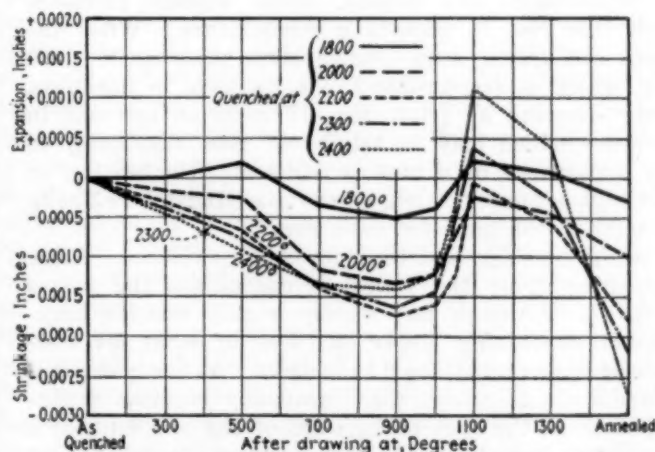

FIG. 1—MEAN VARIATIONS IN LENGTH OF 2.5-IN. SAMPLE OF HIGH-SPEED STEEL

[1] Bureau of Standards Scientific Paper 395, "Relation of the High-Temperature Treatment of High-Speed Steel to Secondary Hardening and Red-Hardness."

was raised, the amount by which the steel expanded on hardening increased (compare the location of the curves at the ordinates marked "As quenched" and "Annealed"). The amount by which the steel contracted after the low draws also increased. It will be observed that with this rise in quenching temperature, the amount by which the steel expanded after a draw in the neighborhood of 1,100 deg. F. also increased. Subsequent contraction, after the drawing temperature of 1,100 deg. was passed, was of course also greater as the quenching temperature was raised.

It appears that these shrinkage measurements throw further light on the reactions inferred from the hardness curves for drawn high-speed steel (Fig. 2) as well as the deductions from the microstructure and from the critical points shown in cooling and heating curves.

HARDNESS, MICROSCOPIC AND THERMAL INVESTIGATIONS

It is proposed to review rather briefly the evidence of other lines of investigation, and then to show how a series of shrinkage curves presents a general picture of all the reactions taking place in a high-speed steel. Shrinkage curves offer as yet no evidence as to the composition of the phases taking part in these reactions, but it is believed that with further refinement this, too, may be forthcoming.

Probably the earliest studies along these lines were in the field of hardness. Fig. 2 summarizes the results of numerous series of hardness measurements on steel of the composition under discussion. It will be seen that if we consider the steel as quenched but not drawn, there is an increase in the scleroscope hardness with rise in quenching temperature, up to a certain quenching range, beyond which no appreciable increase in hardness is produced. When these quenched pieces are drawn, there is a gradual decrease in the hardness, which decrease continues up to drawing temperatures of 900 to 1,000 deg. F. After the steel has been drawn in the neighborhood of 1,100 deg., there is an increase in hardness, which is very pronounced for steels previously quenched from the highest temperatures, but which is in evidence merely as a flattening of the curve at the low quenching temperatures. For still higher drawing temperatures the hardness finally decreases, approaching that of the annealed condition.

From these hardness curves it seems that as the quenching temperature is raised some hard constituent or constituents are formed, whose amount increases with this rise in quenching temperature. When the steels are drawn, some change takes place up to 1,000 deg. which is responsible for a decrease in hardness. After drawing at 1,100 deg., there is an increase in hardness which may be attributed most reasonably to the appearance of a new constituent. On heating at still higher temperatures, all the constituents are finally brought to the annealed condition.

Let us consider next the microscopic evidence. After quenching from the lowest temperatures the pieces show for the most part merely a gray mottled background, containing larger particles of what are considered to be carbides and tungstides. As the quenching temperature is raised, there gradually becomes distinguishable in the gray background of the cold samples a polyhedral structure of what appears to be a new constituent. As the quenching temperature is raised further, the new grains become more distinct and increase in size, and the comparatively large particles of carbide and tungstide decrease in size and number,

being apparently dissolved to make up part of the new constituent. Now this new constituent has been called austenite, from the fact that when a piece showing it is drawn at 1,100 deg., it develops the characteristic structure of martensite. Since martensite found in carbon steels is very hard, it is reasonable to suppose that the martensite in high-speed steels is a very hard constituent, even though it may be of different chemical composition from the martensite of carbon steels. This would account for the hardness developed by drawing at 1,100 deg., which is commonly called "secondary hardness." On heating the hardened steel beyond 1,100 deg. the martensite structure is broken up and the steel returns gradually to the obscure uncertain structure of the annealed condition.

Let us now consider the time-temperature curves found in thermal anaylsis, of which good examples are those developed early by Yatsevich and reproduced by Sauveur in his "Metallography and Heat-Treatment of Iron and Steel," on p. 358. When the highest temperature reached is but slightly above the critical range (say at 1,600 deg. F.) there is a pronounced jog in the

FIG. 2—MEAN VARIATION IN HARDNESS OF HIGH-SPEED STEEL.

cooling curve at about 1,350 deg. F., which corresponds to the transformation from austenite through martensite to troostite. With rise in the temperature to which the steel is heated for taking the cooling curve this transformation at 1,300 deg. decreases in intensity, but there appears a second transformation at about 800 deg. F. This lower transformation, which the writer interprets as a transformation of austenite to martensite, increases in intensity as the initial temperature is raised. The increase in intensity of this martensite transformation naturally indicates an increase in the proportion of martensite in the cooled steel. (This would account partly for the increase in hardness with rise in quenching temperature, but involves the assumption that the microscopic appearance called austenite existing in these highly quenched steels is not really and entirely a solid solution of the various constituents.) If we now turn from the cooling curves to the heating curves, we find on reheating a piece which has been quenched from a high temperature and which is therefore apparently "austenitic" in the microstructure that there is a slight evolution of heat at 1,100 deg. F. This is thought to represent the transformation of some remaining austenite to a second kind of martensite, which also becomes evident in the hardness curves and finally appears in the microstructure.

SHRINKAGE EVIDENCE

We come now to the evidence found in the shrinkage curves. These measurements, when considered in con-

nection with other lines of investigation, present a clear picture of the reactions taking place in heat-treatment.

It must be borne in mind that volume changes induced by heat-treatments may be the result of a combination of at least two factors: (1) The expansion which takes place during the transformation from austenite to martensite, and (2) the contraction which occurs after heating martensite, which is generally supposed to be connected with the formation of carbide molecules and crystals from elemental iron and carbon, but which the present author conceives as due in some measure also to grain growth. The contraction observed after drawing high-speed steel appears to be the same phenomenon as that observed by Andrew, Rippon, Miller and Wragg[3] which is discussed also by McAdam.[3]

We find first of all that as the quenching temperature is raised the difference in volume between the quenched and the annealed condition increases—that is, the expansion on quenching increases. This corresponds very satisfactorily to the increase in the amount of "primary" martensite, indicated in the cooling curves by the increasingly prominent discontinuity at about 800 deg. F., and in the hardness measurements by the increase in hardness as the quenching temperature is raised.

TABLE I—DIFFERENCE IN LENGTH BETWEEN DRAWN PIECES
AND THE ORIGINALS QUENCHED AND NOT DRAWN.

Steel	Drawing Temperatures, Deg. F.			
	800	1,050	1,100	Subsequent 800
Annealed control piece... {	—0.0001	—0.0001	0	+0.0003
	—0.0001	—0.0001	0	+0.0002
Quenched at 2,300 deg.... {	—0.0016	—0.0010	+0.0001	+0.0008
	—0.0016	—0.0012	+0.0003	+0.0007

When this quenched steel is now drawn to temperatures below 1,000 deg. F., the resulting contraction corresponds to the formation of carbide and grain growth in this "primary" martensite formed on quenching. The higher the quenching temperature the greater is this contraction on drawing; this was to be expected because of the presence of a greater amount of martensite which can be decomposed. This contraction, in being attributed to the decomposition of martensite with grain growth and formation of carbides, corresponds satisfactorily to the decrease in hardness of hardened high-speed steels after drawing at temperatures below 1,000 deg. F. This reasoning is based on the considerations presented in Jeffries' slip interference theory of hardening.[4]

After drawing hardened high-speed steels at 1,100 deg. F. there is then a second expansion which corresponds to the formation of a second martensite indicated by the hardness curve, the microstructure and the thermal curves. The expansion at 1,100 deg. acts in the manner which was to be expected. It also points out in a striking manner that the formation of a "secondary" or stable austenite begins soon after the critical point in heating has been passed, because quenching temperatures as low as 1,800 deg. F. induce a marked expansion after drawing at 1,100 deg. The amount of this expansion increases as the quenching temperature is raised until at quenching temperatures

[3]*Journal Iron and Steel Institute*, 1920—I, p. 527.
[3]*Chem. & Met. Eng.*, vol. 25, p. 613, Sept. 28, 1921.
[4]*Chem & Met. Eng.*, vol. 24, p. 1057, June 15, 1921. The slip interference theory fits observed facts so well that the present writer considers it to be completely established. It has served as the background of reasoning for the present paper.

in the neighborhood of 2,300 to 2,400 deg. F. the expansion is very considerable.

It should be pointed out here, and the author wishes to lay emphasis on this point, that it seems inappropriate to refer to the two kinds of martensite formed in high-speed steel by the same name. The probability that they are not the same type of martensite and therefore probably not derived from the same type of austenite was indicated by a separate set of shrinkage measurements. If the martensite formed from the stable austenite by reheating at 1,100 deg. were of the same kind as the martensite formed in quenching, it would behave in the same way and would therefore decompose and show a shrinkage at the same temperatures. The values given in Table I show that the pieces hardened at 2,300 deg. and drawn at 1,100 deg. did not shrink on subsequent reheating up to temperatures of 850 deg. The new martensite is thus much more stable and holds its hardness better than does the "primary" martensite. It is therefore proposed to call the martensite formed on quenching "martensite I" and the martensite developed by subsequent tempering of the austenite "martensite II." It is this martensite II which can be seen readily under the microscope, for after the proper hardening and tempering procedure, martensite II is very coarse. Martensite I is a much less stable material than martensite II and corresponds more to martensites formed in carbon steels or low alloy steels, which are softened by comparatively low drawing temperatures. Martensite II, on the other hand, is the structural constituent which when developed gives to high-speed steel its most valuable high-speed cutting properties.

CONSTITUTION OF HIGH-SPEED STEEL

A general conception of the constitution of high-speed steels in the hardened condition is offered as follows:

It appears that there are present in the hardened steel before it is drawn the three structural constituents troostite, martensite and austenite. In addition there are certain tungstides and carbides, which are present as comparatively coarse granules if the quenching temperature was not high. With a very moderate quenching temperature—1,700 deg. F.—the amount of troostite is quite large, while the amounts of martensite and austenite are very small. As the quenching temperature is raised, the amounts of martensite and austenite increase with a corresponding decrease in the amount of troostite. At the same time it is evident that the absorption of tungstides and carbides increases, with the resultant formation of more austenite of a very stable character existing after quenching and changed only with difficulty to martensite—namely, by reheating to temperatures of 1,100 deg. F. and above.

Formation of martensite I is seen on the cooling curves of Yatsevich in the evolution of heat at about 800 deg. F. in cooling. Its presence is deduced from the shrinkage curves by the expansion on hardening and by the contraction of the steel after tempering up to temperatures of 1,000 deg. F. It makes its presence felt in the hardness by the increase in hardness of the quenched pieces as the quenching temperature is raised (see Fig. 2) and also by the decrease in hardness caused by the decomposition of this primary martensite after drawing the hardened steel at temperatures up to 1,000 deg. F. Formation of this martensite I increases at first rapidly with increase of quenching temperature,

but in the higher ranges of temperature above 2,100 to 2,200 deg. F. further increase in the quenching temperature does not seem to have proportionately as great an effect.

Existence of austenite in highly quenched samples is indicated in the time-temperature heating curves by the transformation (to martensite) when reheating quenched samples at 1,100 deg. F. The increase in the amount of stable austenite with quenching temperature is very evident both in the hardness curves and in the expansion curves, since its presence is deduced from the resultant formation of martensite. When the quenched samples are drawn at 1,100 deg. F., the increase in scleroscope hardness is very marked, especially after a quench in the neighborhood of 2,300 deg. F., as shown in Fig. 2. Expansion due to the appearance of this martensite also appears very plainly at 1,100 deg. F. (Fig. 1). This stable martensite II is decomposed only by subsequent heating at temperatures higher than 1,100 deg., which causes the final contraction of the steel and its return ultimately to the dimensions of the annealed condition.

Change of Properties of Substances on Drying

By Ellwood Hendrick

IN THE lively speech of Prof. H. E. Armstrong at the Glasgow meeting of the Society of Chemical Industry, he referred with great gusto to the work of Prof. H. B. Baker of the Imperial College of Science and Technology. We think his enthusiasm was warranted. A short record of Professor Baker's latest work has been published in the *Transactions* of the Chemical Society (London) for the current year (vol. 121) and for the benefit of our readers we shall review it adding few comments.

The title is "Change of Properties of Substances on Drying" and the significance of his findings will soon appear. Back in 1912 he observed that the boiling points of trioxide and tetroxide of nitrogen were raised respectively 44 and 47 deg. when they were permitted to stand for a long time in contact with phosphoric oxide. The following year he prepared a number of other liquids in a high state of purity, and sealed them up in vessels containing specially purified phosphorus pentoxide, with a view of getting them as dry as possible. Then came the war and the extraordinary duties involved in it, so that the substances Professor Baker had set aside for special drying in this way were left untouched for from 8 to 9 years. When the war was over and the opportunity for research returned, he proceeded to determine the boiling points of these very dry liquids, and he obtained surprising results, very similar to those noted in 1912. That is, the boiling points had gone up from 14 to 60 deg. above normal, although the boiling, when it did take place, was indicated by the formation of bubbles in the heated liquid in each case, and it proceeded quietly, with no sign of the violent ebullition which accompanies the breaking down of a superheated condition. Broken pieces of silica had been placed beforehand in each bulb to prevent superheating. In some cases two thermometers were inclosed in the bulb, one dipping in the liquid and the other suspended about 3 cm. above its surface. The temperatures read in the latter were at most 2 deg. above the normal boiling point of the liquid, and yet when the condensed liquid

from the distillation was again heated it did not boil until the high temperature had been reached.

The following table shows the results of Professor Baker's tests:

	Period of Drying, Years	Original Boiling Point, Deg.	New Boiling Point, Deg.	Rise, Deg.
Bromine	8	63	118	55
Mercury	9	358	420–425	62
Hexane	8½	68.4	82	14
Benzene	8½	80	106	26
Carbon bisulphide	1 plus 27	49.5	80	30
Carbon tetrachloride	9	78	above 112	34
Ethyl ether	9	35	83	48
Methyl alcohol	9	66	above 120	54
Ethyl alcohol	9	78.5	138	60
Propyl alcohol	9	95	134	39

The apparatus used consisted in part of a glass distilling flask with two side tubes. To one of the side tubes was sealed the single side tube of another distilling flask, while the second side tube of the first was drawn out to a long, bent-down tube of about 2 mm. diameter. The necks of both flasks were lengthened by sealing on tubes of similar diameter, which were bent over at the top to form convenient receptacles for the phosphoric oxide. The apparatus was washed and dried thoroughly according to details given, and fragments of fused quartz previously heated were placed at the bottom of each flask. After the introduction of the liquids all openings were sealed and the drying process proceeded for the long period of time provided by the interim of the war and its more pressing duties. With liquids from which no chemical action on the phosphoric oxide was to be feared, such as benzene, hexane or bromine, a plug of the drying agent was placed with the liquid in the flask that contained it. In other cases the drying was performed only on the vapor.

To determine the boiling point the tip of the long tube was dipped under previously boiled mercury and then broken while the depth of the open tube was noted. The liquid was distilled by heating in an oil bath the flask containing it, while the other flask was cooled in water or ice. Then when enough of the liquid was collected in the previously empty flask which formed part of the apparatus, the second flask was heated and the first one cooled. The heating of the oil bath was conducted very slowly so as to allow the liquid to attain the full temperature of the oil. When this approached the boiling point, the heating was slowed down still more.

Experiments on Density and Melting Point

Details of the various experiments are given which we omit for lack of space. We should note, however, that with such a profound change as seemed to take place in these liquids on drying a marked change in density would also be observed. But benzene, carbon tetrachloride, carbon bisulphide, ether, bromine, sulphur dioxide and nitrogen trioxide were each left standing for a year and closed with phosphoric oxide, and the volumes remained the same, although a change of one part in ten thousand would have been easily detected.

Supplementary experiments were made in regard to melting points as follows: A tube containing sulphur which had been purified for atomic weight purposes was set up in 1913 and its melting point was 112.5 deg. The same reading was obtained in 1914, but by 1922 the melting point had become 117.5 deg. Professor Smits of Amsterdam points out that this is a confirmation of his recent theory of allotropy. A sample of iodine, also purified for atomic weight purposes, showed a change from 114 deg. in 1913 to 116 deg. in 1916 after similar

drying in the interval. Experiments are in progress for determining the specific heat of the dried liquids and the density of their vapors.

Professor Armstrong's enthusiasm will now become apparent. The amount of water removed by this long drying is so slight as to be apparently negligible; and yet the results support the hypothesis that at all events in the liquids tested we have aggregations of molecules probably held together by their external fields of force and that in the presence of the very slightest amount of water these aggregates separate or are loosened up. It seems to indicate the presence of colloidal phenomena clear outside the domain of colloid chemistry, to lend a shade of color to the contention that colloid chemistry is universal or, if we would follow Dr. Loeb or Professor Armstrong, that there isn't any such thing and that it is all just plain chemistry. It adds to our knowledge of the amazing qualities of water as a solvent and it carries us a step nearer toward the light in a direction where more light is sorely needed, and that is in the study of what a liquid really is. It is easy enough to visualize the molecules of a gas bumping around like so many balloons, but in a fluid the imagination of familiar things is less helpful. It begins to seem as though there were something like liquid crystals formed of aggregates of molecules and that the presence

of water absorbed or took over the forces that hold them together. It may be that the alcohol molecules, for instance, have a definite geometric shape as suggested by the Lewis-Langmuir theory, and their external fields of force, being the same for each molecule of the same substance, cause them to interlock into the prescribed forms we know as crystals. Then when there is but one molecule of water with its own peculiar and different shape among many thousand molecules of alcohol, the interlocking of the alcohol molecules is prevented. It would be like inserting a block that "doesn't belong" into a picture puzzle. And why does the temperature of the vapor of the dry liquid prove to be only 2 deg. above normal, when taken at 3 cm. above the surface or at its dew point? This note has induced some eminent physicists to declare that for this reason there must be some mistake. But it may be right after all. There may be a time factor in this bunching or aggregation of the liquid molecules, although this is short, for as soon as the condensed liquid gets back to the mass it does not boil until the high degree of heat is reached. The precautions taken make it unlikely that the higher boiling points are due to the presence of any phosphorus compounds.

In fact the whole subject is causing a great deal of dispute in chemical circles in London.

Legal Notes

By WELLINGTON GUSTIN

Tucker Decentralized Control System for Roasting Furnaces Not Invention

In a suit brought by the New Jersey Zinc Co. against the American Zinc, Lead & Smelting Co. in the United States District Court of Maine, the validity of patent 931,815, issued Aug. 24, 1909, to Allen Tucker of Mineral Point, Wis., was put in question.

The Tucker patent in suit involved certain improvements relating to an ore-roasting furnace generally known as the Hegeler furnace, invented by Edward C. Hegeler under patent 303,571, issued Aug. 12, 1884. In this furnace the ore is progressively moved forward on the hearths by rakes which are pulled through the hearths by the rake-moving machinery located at each end of the furnace. Now the Jersey Zinc Co., as plaintiff, says that prior to the invention of the Tucker patent, which it owned, two men were required at each end of the furnace for the raking operation. One man, called the "machine man" or "floor man," concentrated his attention wholly upon the operation of the mechanism or machinery for mechanically moving the rakes. Everything that had movement or which controlled selection or direction was in the hands of that man. He manipulated the control devices from the ground or floor adjacent to the head frame of the rake reciprocating mechanism. The other man, called the "hooker" or "platform man," attended to the hooking and unhooking of the rakes and the guiding of the rods and rakes into the hearths. Since his operating station was at various heights or levels, platforms were provided at each end of the furnace and on each side thereof, upon which the hooker stood in the performance of his duties.

Tucker decentralized the control by placing motor control devices upon each of the seven platforms so that the hooker could operate the mechanism in addition to his regular duties, thus eliminating the floor man.

The question the court asks is, Did Tucker make a patentable invention when he ran the control lines to the platforms instead of running them to the floor? The only substantial thing which he contributed or sought to contribute to the art was the convenience and economy obtained by reducing the number of men necessary to operate the kiln.

SIMPLICITY NOT ARGUMENT AGAINST INVENTION

However, the court says, the simplicity of a device covered by the patent is not an argument against invention. When a thing has succeeded it is very likely to seem plain to any one. A classic quotation is here given.

"The very simplicity of an invention, which leads the inexperienced to infer little merit or application in the inventor, is most commonly the sequel of complications, which in succession have been contrived by him, and in succession been rejected. Indeed, who that ever cast a glance of intelligent observation upon our manufactures, or that has ever been struck with the combined simplicity and efficacy of the means employed, can do otherwise than infer that any one of the means that he admires must have been selected for superiority, when perhaps a thousand others have been rejected?"

Further, it is said that no test has been formulated by which a satisfactory line can be drawn between the products of the inventor's intuition and the results of the mechanic's skill, but that question must be left to a careful exercise of the judgment, guided by the established rules of the law.

Finally, however, the court held that the Tucker patent, for improvements in an ore-roasting furnace which consisted only in lengthening the handles of the controls for certain machinery so that they all could be operated by one man instead of requiring two as heretofore, did not disclose invention and was invalid.

Electrical Characteristics Of Dry Cells—I*

By G. W. Vinal and L. M. Ritchie

Showing the Effect of Temperature on Voltage, Amperage, Shelf-Life, and Tests of Dry Cells—Tables and Curves of Discharge at Constant Resistance and Constant Current Show Capacities to Different End Points at Different Rates

THE Bureau of Standards recently called a conference of leading manufacturers, various government departments and a few of the largest individual users of dry cells to consider the standardization of sizes of dry cells and flashlight batteries, and the revision of the specifications for them. This conference met on Dec. 5, 1921. An abstract of the work of the conference was published in this journal.[1] The sizes of dry cells and flashlight batteries which were adopted as standard are shown in Fig. 1. The data in this paper relate particularly to dry cells of the ordinary size, 2½x6 in.

Effects of Temperature on Dry Cells

EFFECT OF TEMPERATURE ON VOLTAGE

The effect of temperature on the open circuit voltage of dry cells is small and for most purposes can be neglected entirely. The temperature coefficient is
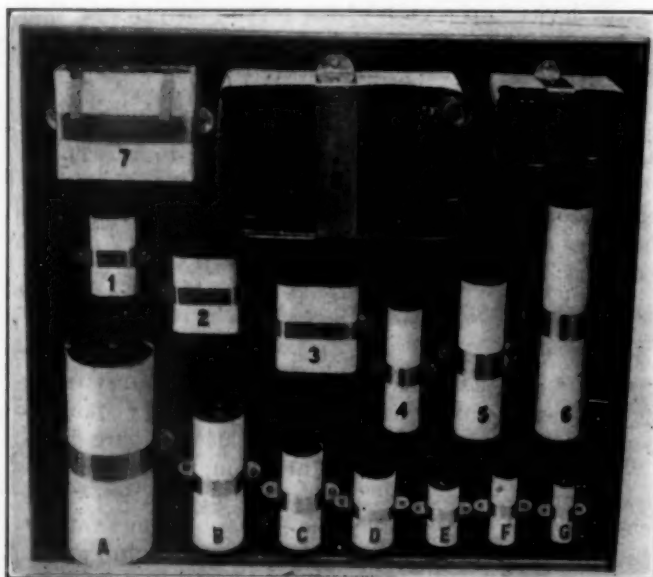

FIG. 1—SIZES OF DRY CELLS AND FLASHLIGHT BATTERIES ADOPTED AS STANDARDS

positive within the ordinary range of temperature—that is, an increase in temperature is accompanied by a rise in voltage. Measurements carefully made on a number of dry cells of various brands and even on different cells of the same brand are not very concordant. Differences are also found between measurements made by a potentiometer and by an ordinary voltmeter, the temperature coefficient appearing to be greater in the latter case. In Fig. 2 is given a curve that represents the average of sixteen different cells, including four different brands measured at the Bureau

of Standards. These cells were all of the No. 6 size and of the paper-lined construction. They were kept at a fixed temperature for at least 24 hours before being measured by a voltmeter having 100 ohms per volt of its scale. The voltmeter measurements are given because they are of the greatest practical use. The effect of extreme low temperatures on the voltage of dry cells is given in Scientific Paper 434 of the Bureau of Standards.

EFFECT OF TEMPERATURE ON SHORT-CIRCUIT CURRENT

Between 0 and 25 deg. C. (32 and 77 deg. F.) the short-circuit current increases approximately 1 amp. for each 3 deg. C. (5.5 deg. F.) rise in temperature.

FIG. 2—EFFECT OF TEMPERATURE ON OPEN CIRCUIT VOLTAGE OF DRY CELLS

Mean of measurements on sixteen cells, No. 6 size, of the paper-lined construction, including four different brands. All cells kept at fixed temperatures 24 hours before being measured.

At higher temperatures the rate of increase is somewhat less. The curve of Fig. 3 shows the relation of the short-circuit current to temperature for a group of six cells of the paper-lined construction measured at the Bureau of Standards. Each point plotted is the

FIG. 3—EFFECT OF TEMPERATURE ON SHORT-CIRCUIT CURRENT

Mean values for a group of six cells maintained at each of the temperatures indicated for at least 24 hours prior to the measurement.

mean value of the six cells after they have been kept at the temperature indicated for at least 24 hours. The temperatures were taken in the following order, 22, 0, 22.5, 8, 0, 21.8, 35, 41, 8, 16.8 and 9 deg. C. This shows that the shape of the curve is well defined and that the short-circuit current reading at any temperature can be repeated with fair accuracy when the temperature of the cell is brought back to the same value.

EFFECTS OF TEMPERATURE ON STORAGE

Heat produces deterioration of dry cells in two ways. First, it tends to produce leakage; this may be observed when the sticky electrolyte has oozed out around the seal of the cell. Second, it increases the rate of the chemical reactions taking place within the cell. The deterioration of the cells is usually measured by the decrease in the short-circuit current with time when the cells are stored on open circuit. This is not a true criterion of the decrease in service capacity of the cells, but is a convenient method of estimating the depreciation. In Table I is given the percentage decrease

TABLE I—EFFECT OF TEMPERATURE ON THE SHORT-CIRCUIT CURRENT OF DRY CELLS STORED ON OPEN CIRCUIT

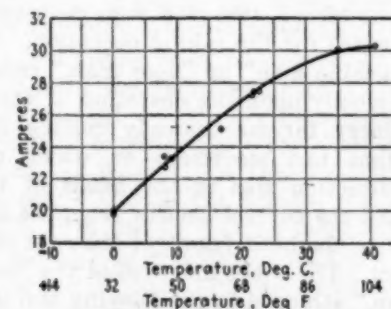| Temperature of Storage	Percentage Decrease in Short-Circuit Current at End of 10 Weeks
5° C. (41°F.)	4
25° C. (77° F.)	10
35° C. (95° F.)	19
45° C. (113° F.)	25
55° C. (131° F.)	52
65° C. (149° F.)	71
75° C. (167° F.)	98

in short-circuit current at the end of 10 weeks for cells stored at various temperatures. The figures have been taken from an article by Pritz.[3] Recent experiments show that the measurements of Pritz for cells stored at 25 deg. C. are approximately correct for dry cells when new, but the rate of decrease of short-circuit current becomes less as the age of the cell increases, the total decrease during a year at room temperature being about 25 per cent. The table shows that it is necessary to keep the cells as cool as possible while they are in storage or being shipped. Temperatures of 55 deg. C. or above are not likely to be reached under any ordinary conditions of storage.

EFFECT OF TEMPERATURE ON SERVICE CAPACITY

For heavy service a moderately high temperature is desirable, but for light service a low temperature is better. The data of Table II are taken from Pritz,[3] showing the hours of continuous service from cells of one manufacturer when discharged through various resistances until the closed-circuit voltage had fallen to 0.5 volt. The cells used for these measurements were the 6.5x15 cm. (2½x6 in.) size. Exactly the same figures for the 2-ohm test were also given by Ordway.[4]

Table II shows that 50 deg. C. (122 deg. F.) is the most favorable temperature when the external resistance is 8 ohms or less. However, a word of caution is necessary in applying this table to actual use. This is a continuous test, while cells are used ordinarily only part of the time. Hence the heat that may seem to make the cell more efficient in some cases may also cause so much deterioration during the idle periods as to be disadvantageous. For example, Table II shows 160 hours' service at 50 deg. C. when discharging

[3] *Trans. Am. Electrochem. Soc.,* vol. 19, p. 39, 1911.
[3] *Idem,* vol. 19, p. 39, 1911.
[4] *Idem,* vol. 17, p. 358, 1910.

TABLE II—HOURS OF SERVICE OF DRY CELLS DISCHARGED TO 0.5 VOLT AT VARIOUS RATES AND TEMPERATURES

Temperature	Resistance of External Circuit in Ohms			
	2	4	8	16
0° C.(32° F.)	40	80	270	560
25° C.(77° F.)	60	94	260	700
50° C.(122° F.)	70	160	250	650
75° C.(167° F.)	65	158	315	615

TABLE III—HOURS OF SERVICE OF DRY CELLS, NO. 6 SIZE, DISCHARGED TO 0.6 VOLT AT FIXED RATES OF CURRENT AND AT VARIOUS TEMPERATURES

(Average of results of tests made on 3 standard makes of dry cells of paper-lined construction.)

Temperature	Service at Various Rates of Discharge in Amperes				
	0.1 Hours	0.25 Hours	0.50 Hours	0.75 Hours	1.00 Hours
0° C.(32° F.)	136	40	14	7	5
25° C.(77° F.)	220	64	24	13	9
30° C.(104° F.)	300	94	31	18	11

through 4 ohms; but this is less than 7 days. Table I shows that at this temperature the deterioration of the cell as measured by the short-circuit current is about 4 per cent per week on the average. If the cells were to be used over a period of several weeks, the hours of actual service obtainable would be much less than those shown in Table II. The obvious remedy is to keep the temperature lower.

The data given in Table II apply to cells discharging through a fixed resistance. It is also of importance to have data for cells discharging at a fixed rate of current. Results of tests recently made at the Bureau of Standards are given in Table III. The temperatures were kept constant by thermostatic control and the current in each case was maintained at the fixed value day and night throughout the test.

Capacity of Dry Cells

Since dry cells are mostly used on circuits of which the resistance is constant or nearly so, the capacity is usually expressed as the number of hours or days that the cell will continue to give service on such a circuit. This period is calculated to the time that the terminal voltage has fallen to some arbitrary value below which the service is not satisfactory. For example, the cut-off voltage of a group of three coils for telephone service is 2.8 volts. Such service is intermittent and extends over a number of months. The capacity of dry cells may also be expressed in terms of ampere-hours and watt-hours, but to obtain these data it is necessary to integrate carefully measured discharge curves. In any case the capacity, whether expressed as hours, ampere-hours or watt-hours, depends on the condition of the cells, the way they are made and the arbitrary choice of the cut-off voltage. In the pages that follow the most reliable data for the capacity of standard makes of No. 6 paper-lined cells discharging through fixed resistances and at constant current rates are given.

Table V shows clearly the gain in hours of service that is to be obtained by making the current drain light. For the cut-off voltage of 1.2 volts discharging through 2 ohms, 2.2 hours was obtained, but through 8 ohms the cell gave twenty times the service and through 64 ohms, 480 times the service.

Table V shows that when the voltage has fallen to one-half its initial value the cell is by no means one-half discharged. The true measure of discharge of the cell is the ratio of the energy delivered to the total energy contained, and this must be measured in watt-hours.

Just as the voltage is not a criterion of the service capacity remaining in the cell, so also the short-circuit current is not a true measure of the cell's capacity.

TABLE IV—INITIAL WORKING VOLTAGE OF NO. 6 DRY CELL

Ohms Resistance of Circuit	Corresponding Amperes Drain	Initial Working Voltage
0.00	*42.9	*0.00
0.01	*32.0	*0.32
0.02	*26.5	*0.53
0.04	*18.5	*0.74
0.08	*12.0	*0.96
⅛	8.8	1.10
¼	5.1	1.28
½	2.76	1.38
1	1.45	1.45
2	0.735	1.47
4	0.370	1.48
8	0.185	1.48
16	0.092	1.48
32	0.046	1.48
64	0.023	1.49
128	0.0117	1.50
256	0.0059	1.52
512	0.0030	1.52
Infinity	0.0000	1.53

* Estimated by exterpolation.

Excessively large short-circuit currents when the cell is new do not indicate that such cells will give more service than others yielding average currents. These excessive currents which are sometimes produced for advertising purposes may be the result of harmful additions to the usual ingredients of the cell. With any given brand of cell, a test that shows, for example, a decrease of 40 per cent in the short-circuit current does not mean that 60 per cent of its service capacity remains.

DISCHARGE THROUGH CONSTANT RESISTANCES[a]

Initial Working Voltage.—It is important to know what working voltage can be expected from the cell at

[a]The subsections headed "Discharge Through Constant Resistances" and "Constant Current Discharge" are chiefly from a paper by C. A. Gillingham, *Trans. Am. Electrochem. Soc.*, vol. 34, p. 297 (1918), by permission.

the beginning of its service life under various discharge conditions. This of course is lower than the initial open circuit e.m.f. of the cell because of what is usually assumed to be the internal resistance of the cell. It varies with the current being drawn from the cell or with the resistance of the external circuit according to the figures in Table IV.

With circuits of greater than 1 ohm the initial working voltage is but slightly lower than the open circuit e.m.f. The difference between open and closed circuit voltage is not readily calculated from the value for the internal resistance of the cell because the latter is not a constant quantity since it varies with the current being drawn from the cell, from about 0.04 ohm at heavy drains up to several ohms at light drains.

Continuous Discharges.—In the first section of Table V will be found the life in hours to various cut-off voltages for cells discharged through various resistances.

A number of curves have been drawn based on the figures in Table V from which the characteristics of the cell can be studied more readily than from the table of figures.

If the cell discharged at the same efficiency through all resistances, a cell giving 100 hours through 10 ohms, at the same service efficiency should give 10 hours through 1 ohm and 1,000 hours through 100 ohms, etc. The efficiency, however, rises more rapidly for increasing resistances up to the region of 60 to 100 ohms, above which the rise is lower than for equal efficiency. It follows, therefore, that up to this region the efficiency is increasing, and above it decreasing. There-

TABLE V—HOURS OF SERVICE FOR NO. 6 DRY CELL

Cell Discharged	Cut-Off Voltage	⅛	¼	½	1	2	4	8	16	32	64	128	256	512	1,024	1,792
Continuously (1)	1.2	....	0.02	0.13	0.70	2.2	9.1	47	115	390	1,050	2,780	2,220	6,350	7,850	9,120
	1.0	0.01	0.21	0.95	3.7	11.1	32.5	89	233	650	1,560	3,200	4,800	6,850	9,720	10,740
	0.8	0.14	0.76	2.3	7.4	20.7	53.0	119	304	740	1,750	3,350	5,100	7,300	10,200	11,500
	0.6	0.50	1.9	5.1	12.5	36.3	75.0	184	383	805	2,470	3,500	5,220	7,550	10,570	11,800
	0.4	1.4	3.8	8.5	21.4	49.8	100.0	227	462	890	2,530	3,650	5,350	7,700	10,970	12,100
30 minutes every hour (2)	1.2	....	....	....	1.0	4.0	15.0	40	210	550	1,370					
	1.0	....	....	(1.1)	5.5	13.0	37.0	120	320	810	1,570					
	0.8	(0.2)	(0.8)	(3.0)	9.0	26.0	61.0	190	375	920	1,630					
	0.6	(0.7)	(2.0)	(5.6)	15.5	43.0	87.0	230	420	1,000	1,680					
	0.4	(1.5)	(4.0)	(9.7)	25.0	58.0	120.0	280	470	1,040	1,750					
15 minutes every hour (3)	1.2	....	....	....	1.0	5.0	13.0	90	240	580	1,225					
	1.0	....	0.17	1.2	5.0	17.0	47.0	157	370	815	1,275					
	0.8	0.31	1.0	3.0	10.5	40.0	80.0	195	445	875	1,325					
	0.6	0.91	2.3	5.1	16.5	74.0	100.0	223	500	920	1,370					
	0.4	2.0	4.3	11.0	29.0	89.0	122.0	264	560	965	1,420					
5 minutes every hour (4)	1.2	....	....	0.18	2.5	1.5	45.0	115	292	508						
	1.0	....	0.34	2.0	7.5	28.0	75.0	166	360	542						
	0.8	0.21	1.2	4.1	13.5	40.0	93.0	201	385	567						
	0.6	0.75	2.3	6.4	20.0	50.0	114.0	224	403	602						
	0.4	1.9	4.3	11.0	33.0	62.0	128.0	236	416	625						
2 minutes every hour (5)	1.2	....	....	0.53	3.5	22.0	56.0	152	207	272						
	1.0	0.06	0.53	2.3	13.0	35.0	78.0	167	216	288						
	0.8	0.28	1.3	5.4	19.5	44.0	90.0	194	224	307						
	0.6	0.72	3.0	10.0	28.0	59.0	103.0	209	231	333						
	0.4	1.8	6.0	15.0	36.0	68.0	109.0	217	240	....						
½ minute every hour (6)	1.2	....	....	2.0	8.7	22.0	42.0	70	....	....						
	1.0	....	1.6	6.0	15.7	29.0	46.0	76	....	....						
	0.8	0.80	3.7	8.5	17.7	31.0	48.0	80	....	....						
	0.6	1.9	6.5	12.0	20.0	33.0	50.0	82	....	....						
	0.4	5.2	10.3	16.0	23.0	36.0	52.0	85	....	....						
5 minutes every 10 minutes (7)	1.2	....	....	0.14	1.5	5.0	20.0	40	220	530	1,280	2,550				
	1.0	....	0.42	1.3	6.0	14.5	45.0	115	340	795	1,580	2,800				
	0.8	0.45	1.5	3.3	9.5	28.0	70.0	170	410	930	1,670	2,850				
	0.6	1.3	3.0	6.0	16.5	45.0	105.0	220	460	1,010	1,730	2,875				
	0.4	2.3	4.8	9.0	26.0	60.0	135.0	270	520	1,100	1,810	3,000				
30 minutes every 6 hours (8)	1.2	....	....	....	1.3	15.0	40.0	107	309	460						
	1.0	....	....	....	9.5	29.0	75.0	137	353	505						
	0.8	....	....	....	17.0	40.0	93.0	186	367	545						
	0.6	....	....	....	24.0	48.0	102.0	216	381	590						
	0.4	....	....	....	30.0	56.0	111.0	228	395	625						
5 minutes every 6 hours (9)	1.2	....	....	0.2	4.1	17.0	56.0	....	....	....						
	1.0	....	0.24	2.9	11.2	32.0	61.0	....	....	....						
	0.8	0.34	1.7	6.7	16.3	37.0	63.0	....	....	....						
	0.6	0.9	3.5	10.2	21.0	42.0	65.0	....	....	....						
	0.4	2.8	6.5	14.0	26.0	47.0	82.0	....	....	....						

Note:—Figures in parentheses are interpolated.

fore, the maximum efficiency lies in the vicinity of 60 to 100 ohms depending on the cut-off voltage.

Fig. 4 shows the continuous discharge results of the first section of Table V plotted in terms of hours per ohm as ordinate and a logarithmic scale to the base 2 of ohms for the abscissa. By this method it is possible to put all of the results on the same plot without crowding the curves together in the region where there is the most occasion to use them. The actual hours of discharge are readily calculated from the hours per ohm by the following relations:

Hours of discharge = hours per ohm

× ohms in discharge resistance.

This plot shows the following characteristics of continuous dry cell discharges:

(*a*) For any cut-off voltage the efficiency rises to a maximum as the resistance of the discharge circuit increases and then falls off rather abruptly.

(*b*) An increase in cut-off voltage causes this maximum point to move to the right.

The reason for the increasing efficiency as the resistance becomes greater (and hence the service lighter) is no doubt due to the increasing completeness of the depolarization. It becomes practically complete at 64 ohms.

The falling off in efficiency for services lighter than that equivalent to a discharge through 64 ohms is because of the local action within the cell, which is often referred to as the shelf-life deterioration.

Local action consumes the zinc can and the other constituents as well as the useful service which the cell renders, so that as the period of discharge is increased there is a relatively smaller amount of these available for service reactions.

It will be apparent also from examination of Fig. 4 that the shape of discharge curve for low resistances must be quite different from that for high resistances. The relative distances between the various cut-off voltages show this.
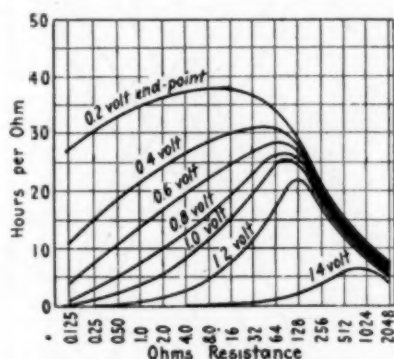

FIG. 4 — SERVICE EFFICIENCY CURVES FOR CONTINUOUS DISCHARGES THROUGH VARIOUS RESISTANCES

Intermittent Discharge.—The results of the various intermittent tests are shown in Table V, from the second division down. It will be noted that the first five of these together with the continuous division form a series of various length discharges in hourly cycles as follows:

    60 minutes per hour (continuous)
    30 minutes per hour
    15 minutes per hour
    5 minutes per hour
    2 minutes per hour
    ½ minute per hour

In Fig. 5 are shown the efficiency curves to the 0.8 volt end point for the various periods of hourly discharge. The maximum efficiency points move to the left toward the lower resistances as the period of discharge becomes lower, just as in Fig. 4 they move to the left as the cut-off voltage is lowered. The latter is true regarding the cut-off voltage for any given period of discharge less than 60 minutes, just as it is for the continuous tests.

This leads us to a consideration of what is called "severity of service." Severity of service decreases with increased resistance and decreased period of closure. In other words, severity of service is analogous to average rate of output. Two cells would be working at the same average rate of output if, for instance, one discharged at 1 amp. continuously and the other at 10
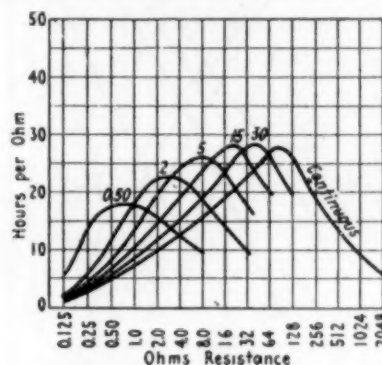

FIG. 5 — SERVICE EFFICIENCY CURVES TO THE 0.8 VOLT END POINT FOR VARIOUS PERIODS OF DISCHARGE

Numbers on curves refer to minutes of discharge per hour.

amp. for one-tenth of an hour each hour. Each would deliver 1 amp.-hr. per hour. "Severity of service" may be defined as equal to the percentage of the total time during which the cell is actually discharging, divided by the resistance of the circuit. When the severity of service is low, all the discharge curves for various rates coincide if the hours of service are plotted against the severity of the service to any given cut-off voltage. In other words, the efficiency and shape of the curve are approximately the same for the same severity of service whether the discharge is continuous or intermittent. This applies to service through a resistance of 16 ohms or more.

Thus far all conclusions regarding the intermittent characteristics are based upon the series in which one cycle occurs every hour, the period of discharge varying between ½ and 60 minutes. In order to ascertain the effect of cycles longer and shorter than 1 hour, tests were made as follows:

    5 minutes every   10 minutes
    30 minutes every   6 hours
    5 minutes every   6 hours

The figures for these tests are shown in the 7th, 8th and 9th divisions of Table V.

Tests run 5 minutes every 10 minutes are discharging the same percentage of the total time as those run 30 minutes per hour. By comparing the results for these two tests (divisions 2 and 7 of Table V), it will be found that the two are identical (within the limit of error), except in the very low resistances, where a considerable difference is found, particularly at the higher cut-off voltages. The results are of course lower

for the longer 30-minute discharge period than for the shorter 5-minute period. The same will appear by a comparison of the 30 minutes every 6 hours with the 5 minute per hour tests (divisions 4 and 8, Table V). Appreciable discrepancies occur only when the resistance is below 1 ohm. In most cases, therefore, it may be assumed that any discharge cycle will give the same results as the 1-hr. cycle with the discharge covering
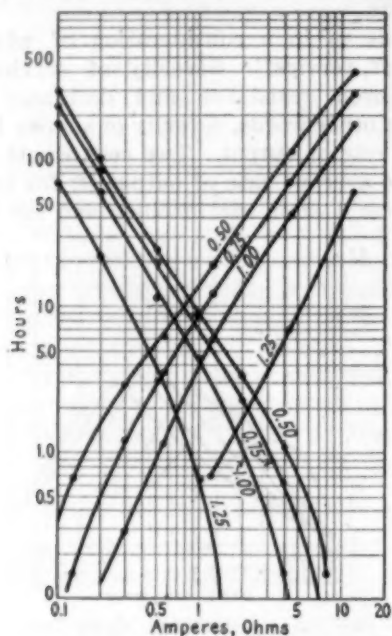

FIG. 6—CONSTANT CURRENT AND CONSTANT RESISTANCE DISCHARGE. 25 DEG. C.

the same proportion of the time. This statement, of course, must be applied with discretion especially in cases of discharge periods of considerable length and moderate resistances.

CONSTANT CURRENT DISCHARGE

In Table VI are shown the results of a number of tests in which the resistance of the circuit was varied as the cell ran down so that the current drain remained constant in value throughout the test. In the constant resistance discharges, of course, the current drain decreases in direct proportion as the working voltage of

TABLE VI—HOURS OF CONTINUOUS CONSTANT CURRENT DISCHARGE

Cut-off Voltage	Amperes						
	8	4	2	1	0.5	0.2	0.1
1.2	.....	0.015	0.12	0.7	4.0	20	78
1.0	.....	0.24	0.82	3.6	13.5	49	140
0.8	0.047	0.43	1.9	6.3	21.0	66	183
0.6	0.137	0.82	3.1	9.2	27.5	80	220
0.4	0.240	1.29	4.3	12.0	36.0	92	237

the cell decreases. The cell, therefore, delivers current at a slower and slower rate as it becomes exhausted. In the constant current test, however, the cell is forced to deliver current at the same rate when nearly exhausted as at the beginning of the test. It is therefore to be expected that the discharge curve will drop less rapidly at the beginning and more rapidly at the end than for a constant resistance test of about the same average drain.

COMPARISON OF DISCHARGE THROUGH CONSTANT RESISTANCES WITH DISCHARGES AT CONSTANT CURRENT

Dry cells have been commonly used on circuits of which the resistance is constant, such as telephone,

ignition and bell circuits. There is now a growing tendency to use them also as a source of power for the operation of radio and other apparatus for which a constant current is necessary. The duration of the discharges of both kinds to various cut-off voltages are given in Tables V and VI (Gillingham's measurements) and also in Figs. 6 and 7, which are plotted from results obtained at the Bureau of Standards. Different brands of cells were used in making these experiments and the temperature also differed by several degrees. It is not surprising, therefore, that there are slight differences in the results, but the general agreement indicates that the performance of paper-lined cells of standard make is reasonably uniform and consistent. The curves which are given apply to continuous discharges at constant current and through constant resistances.

In order to determine the constant current at which a cell must discharge to give comparable service to that which it can give on a constant resistance circuit, Figs. 6 and 7 may be used. The former applies to the paper-lined cells and the latter to a bag-type cell of American manufacture. In either figure the curves sloping downward to the right are for the discharge at constant current for which the abscissas are amperes. The curves sloping downward to the left are for discharges through constant resistances. For these the abscissas are ohms. Example: To determine the constant current which will give the same service to 0.75 volt as for the cell discharging through 5 ohms. Starting at the 5 ohm point at bottom of diagram, follow the line vertically upward to its intersection with the curve marked 0.75 and then follow the ordinate horizontally to the left to its
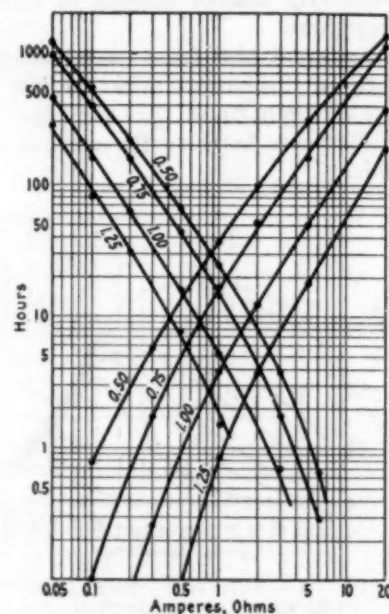

FIG. 7—CONSTANT CURRENT AND CONSTANT RESISTANCE DISCHARGE. 25 DEG. C.

intersection with the other curve marked 0.75. From this intersection follow line vertically downward to scale of amperes at the bottom of the diagram. On Fig. 6 this is found to be 0.19 amp.

AMPERE-HOUR CAPACITY

The ampere-hour capacity of dry cells does not possess the theoretical interest or practical value which the ampere-hour capacity has for storage cells, but it is occasionally necessary to determine it. This may be
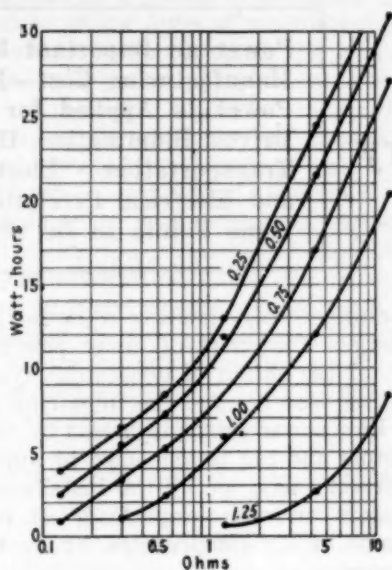
FIG. 8—WATT-HOUR CAPACITY.
CONSTANT RESISTANCE
DISCHARGE. 25 DEG. C.

done for continuous discharges with the aid of Figs. 6 and 7.

When the cells are discharged at a constant current rate, the capacity in ampere-hours to any specified cut-off voltage can be calculated immediately. It is the product of the current by the duration of the discharge. Thus in Fig. 6 the ampere-hours for a cell discharging at a fixed rate of 0.5 amp. to 0.75 volt is found to be

$$0.5 \times 19 = 9.5 \text{ amp.-hr.}$$

The more usual case, however, is for the cell to be discharged through a fixed resistance, the current decreasing as the discharge progresses, because of the falling voltage of the cell. The equivalent constant current may be estimated for the discharge through any value of resistance shown in either Fig. 6 or 7 as described in the preceding section and from this the approximate equivalent in ampere-hours computed. An example was given in which the constant current equivalent to a discharge through 5 ohms to an end point of 0.75 volt was found to be 0.19 amp. The time of the discharge was 85 hours. The ampere-hours were

$$0.19 \times 85 = 16 \text{ amp.-hr.}$$

The most exact way of computing the ampere-hours is to determine the current flowing at a number of periods during the discharge of the cell by dividing the terminal voltage of the cell at such times by the fixed resistance of the circuit. From these values a plot can be made and the average value of the current during the discharge obtained by integrating the curve with a planimeter.

It should be remembered that the performance of different brands of cells differs considerably and that the age and temperature conditions also have a marked influence. The performance of typical brands of cells given in Figs. 6 and 7 serve only as a rough indication of the period of service and ampere-hour capacity that may be expected under other conditions.

WATT-HOUR CAPACITY

The watt-hour capacity is of greater interest than the ampere-hour capacity, because it represents the actual energy that can be derived from the cell. It is not computed as easily as the ampere-hour capacity, because of the necessity of determining the average

voltage, which changes throughout the period of discharge.

If the discharge is made at constant current, the average voltage is most simply obtained by plotting the voltage readings and integrating the curve by a planimeter. In this case the watt-hour capacity is the product of the average voltage by the fixed value of current and by the period of discharge to any predetermined cut-off voltage.

If the discharge is made through a fixed resistance, both the current and the voltage vary throughout the discharge. It is then necessary to plot a curve of the voltage squared for integration. The watt-hour capacity is determined as the product of the average value
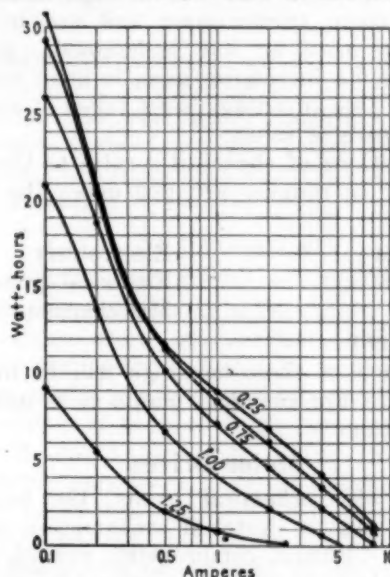

FIG. 9—WATT-HOUR CAPACITY.
CONSTANT RESISTANCE DISCHARGE. 25 DEG. C.

of the voltage squared multiplied by the time of the discharge and divided by the fixed value of the resistance.

Since the watt-hour capacity of the cells cannot be computed from any of the preceding data, curves of Figs. 8 and 9 are given for continuous discharges of the ordinary paper-lined cells of No. 6 size discharging through fixed resistances and at constant current to the cut-off voltages indicated on the individual curves.

Part II will appear in a subsequent issue.

Failure of Paint and Varnish on Exposure to Weather

During the recent meeting of the American Society for Testing Materials at Atlantic City there was an extended informal discussion of the mechanism of failure of paint and varnish films on exposure to the weather. One party to the discussion claimed that a paint or varnish film should contain moisture in order to retain its elasticity. The known beneficial effect of baking a varnish film was then cited as being contradictory to this theory that moisture improved the durability of paint or varnish. The importance of the problem makes it appear advisable to study baked varnish films in order to obtain some definite data on the effect of baking. The Bureau of Standards has commenced an investigation in which a series of spar varnishes of varying strengths of oils will be baked on tin panels at different temperatures, and then tested for durability when exposed to the weather.

Application of Electric Service To the Chemical Industry

BY WILLIAM B. TODD

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> Power an Important Part of Manufacturing Cost—Electric Power Is Applied for Motor Drives, Illumination, Heating, Transportation, Electrolysis and Electrical Precipitation— Some Points to Be Observed

POWER forms a large percentage of manufacturing cost in many chemical industries. But how many plant managers are familiar with the many applications of power? To the average manufacturer steam generation, transmission and use in chemical processes are more or less understood. Electricity, however, with its increasing uses, is little understood; and in many cases advantage is not taken of applications that would prove of value.

The applications of electrical service to the chemical industry may be roughly grouped under the following headings:

Motor drives   Electrolysis
Illumination   Electrical precipitation
Heating   Miscellaneous uses
Transportation

Consideration of these headings will be briefly discussed. There are chemical plants now using all of these applications.

Motor Drives

Except in electrochemical plants, the largest percentage of a plant's electrical consumption is used in motor drives. Pumps, compressors, mixers, grinders, agitators, beaters, centrifuges, rotary driers, continuous filter presses, nitrators, etc., are all driven efficiently by electric motors if proper applications have been made. By proper motor application is meant the strict attention to correct type, correct size and correct installation.

Before selection of the correct type it will be necessary to consider the two classes of electric motors— direct current and alternating current. Except in older plants it will be found that alternating current is in general use on account of the advantages this system offers in the reduction of transmission losses and line costs, due to the ability to transform to higher voltages and consequent lower current and the use of smaller wire sizes.

Electrical service may be generated or purchased. The electric utility companies as a rule furnish only alternating-current service and the majority of chemical plants generating their own power use the alternating-current system. The problem of generation or purchase of electrical service will not be discussed here, as we are dealing with its application. The cycle of plant operations, however, must be so arranged that unusual peaks will not obtain, the penalty being increased costs due to the "demand charge" if power is purchased and investment in increased generating capacity if generated.

USE OF ALTERNATING-CURRENT MOTORS

With alternating-current systems we are confronted with the power factor condition. The power factor in most industrial plants is "lagging" and represents the current doing real work in electrical machinery compared to that doing real work plus the amount doing "wattless" or unnecessary heating work in the coils of that machinery. The effect of lower power factor is the reduction of the output of generators, transformers and distributing feeders; and the impairing of voltage regulation. Low power factor is caused by underloaded induction motors and can be remedied by application of motors of correct rating or by the installation of synchronous motors on such large loads as continuous-operated pumps or air compressors, or by the use of static condensers.

These last two items of electrical equipment cause a "leading" current in the lines and will neutralize the lagging power factor caused by underloaded induction motors. Correction of power factor will save investment in added plant generating capacity.

It is generally conceded that alternating-current motors are more reliable and, in the case of the chemical industry, safer than direct-current motors, due to absence of commutators and their attending troubles. Direct-current motors are designed for 110-, 220- or 550-volt service, while alternating-current motors may be designed for various voltages, phases and frequencies, but the specifications in most general use are 110, 220, 440, 550 or 2,200 volts, two- or three-phase (single-phase for fractional horsepower motors) and twenty-five or sixty cycles. The direct-current motors are divided into three types—series, shunt and compound. The alternating-current motors in industrial use are the squirrel-cage induction motor, the slip-ring induction motor and the synchronous motor.

CORRECT APPLICATION OF MOTORS

For correct application to various loads the following table will roughly cover the type of motor to be used:

Nature of Load		Direct Current Motor	Alternating Current Motor
Speed	Starting Torque		
Constant...	Low.......	Shunt	Squirrel-cage or synchronous
Constant...	High......	Compound or series.	Slip-ring
Variable...	Low.......	Shunt or compound.	Slip-ring
Variable...	High......	Compound	Slip-ring

Synchronous motors, due to their higher cost and necessity of direct current for their fields, are seldom used in industrial plants except in large sizes to improve power factor conditions as has been explained before. Slip-ring motors are not efficient at speeds under synchronous speed rating, but afford the only practical method of obtaining variable speeds with alternating-current motors. The nature of the load to be driven should thus be carefully considered before selecting the proper type of motor.

CHOOSING THE CORRECT SIZE OF MOTOR

One of the greatest faults in the application of motors has been that of "over-motoring" or installing motors of too large capacity. This fault has been caused by the desire to play safe; but, due to it, there are today many plants operating motors at greatly reduced efficiencies and power factor, and consequent higher power costs, as the maximum efficiency and

power factor of a motor is at rated load. Whether individual or group drive of machinery is used, careful tests should be made to obtain the average and maximum loads, and the proper size motor installed.

Motor ratings are based on the maximum continuous temperature at which the heat caused by the passage of current through the windings will be dissipated at the same rate as generated. Commercial motors are now manufactured with 40 deg. C. and 50 deg. C. ratings, expressing the permissible temperature rise above an ambient temperature of 20 deg. C.—at rated capacity. The 40 deg. motors permit of an overload of approximately 25 per cent above normal rating, while 50 deg. motors permit of no overload. Naturally the 50 deg. motors are cheaper and in purchasing motors the difference in ratings should be taken into consideration.

CORRECT INSTALLATION OF MOTORS

Correct installation is particularly important in chemical manufacturing buildings. It is well worth the higher installation cost to use 30 per cent para rubber insulation for conductors and to run the conductors in metal conduit, lead cable or in grooved timbers. This latter installation is fairly expensive; but, where metal conduit would be eaten through in a few weeks, the grooved timber and asphaltum-like compound will combine to give good service. The timbers are run through the entire length of the building and the connections to the circuits made on the exterior of the building. Lead cable, while more satisfactory in withstanding acid fumes than metal conduit, requires considerable lead burning; and, due to the mechanical injury that it is likely to receive, acid will leak into the wiring. Safety switches, overload relay and no-voltage release coils on starting apparatus and the installation of all electrical equipment from a safety standpoint are all-important.

In acid buildings it is often advisable to make up oil-switch boxes containing a lead reservoir filled with transformer oil, so that the fuse blocks and all of the knife switch but the handle are submerged in oil. Motors are frequently installed in motor houses outside of the manufacturing building and the power transmitted to the machinery in the building either by a belt carried through a duct or by a shaft containing a pulley in the motor room. Remote control of motors from push-button stations offers operators a convenient method of starting and stopping their machines and in buildings where there are dangerous operations the installation of these push-button stations at different points is a step toward safety of operation. In the explosives end of the chemical industry it is frequently advisable to start and stop the operation of machinery at some distance from the building and the push-button stations are mounted on posts at a proper distance from the operation.

PROTECTION OF MOTORS FROM FUMES

For protection of motor windings against acid and other chemical fumes it has been found necessary to coat them with a solution of flexible black enamel and flexible compound and bake from 40 to 60 hours at 75 deg. F. (36 deg. C.). The motor is then removed from the oven and while still hot it is suspended by a sling so that the protruding windings can be lowered into a large flat pan containing compound similar to asphalt, but having a much higher melting temperature.

Motors receiving this treatment will withstand exposure to fumes that would put factory-impregnated motors out of business in a very short time. This protection, however, will gradually break down due to contraction, expansion and vibration of the stator laminations. A "dope" gang is therefore employed to prevent this breakdown. This gang neutralizes the acid deposits on the motors by swabbing with a solution of soda ash and alcohol, wirebrushing and sandpapering the metal parts and coating the winding with Harrison's quick-drying asphaltum paint applied with a paint "gun." The paint gun operates somewhat on the principle of a blow torch, the pressure being applied either by the plant air line or a tire pump. The "gun" is superior to a brush in applying the paint into every recess where fumes can enter.

The more important advantages of electric motor drives are:

1. Direct application of power where desired.
2. Minimizing of shafting and belting to give better illumination and handling of material.
3. Constant speed, causing increase of production.
4. Reliability, as breakdowns are usually confined to a single machine.

Illumination

Proper illumination has increased production in many industries, particularly in shops where hand and accurate machine work predominate. In the chemical industry the operations consist mainly of tending machines, and, as a general rule, the lighting system should consist of general direct lighting, an average of 1 to 1.25 watts per sq.ft., with local lighting at sight glasses, peep-holes, gages and places where greater intensity is desired.

The chief problem in interior illumination is to avoid fatigue and injury to the eyes of the operators by reduction or elimination of glare. This is accomplished by properly shaped reflectors and frosting of lamps. Indirect lighting does not, as a rule, lend itself to chemical operations due to the style of construction of chemical factory buildings. On account of fumes from most operations it is advisable to use vapor-proof globes. Where the explosive risk exists it is advisable to illuminate the interior by means of lamps inclosed in tilted glass front boxes mounted on the walls, the backs of the boxes permitting opening from the exterior of the building, and the circuits being run open on knobs on the exterior of the building to permit easy inspection. The outside type of reflector installed outside on posts opposite windows affords illumination for the interior of buildings with a high explosive risk.

It has been found advisable by safety authorities to restrict the use of nitrogen-filled Type "C" lamps in buildings of the chemical industry due to the high surface temperatures of these lamps. Lamp guards are advisable where there is a possibility of contact, particularly in the case of lamps at low heights. Drop-cord lighting should never be used where there is a vapor or dust risk. The installation of red lights over safety shower baths in acid buildings is very desirable. As many chemical operations are continuous, all passageways should be lighted and outside lighting carefully planned so that the operation of the plant on the night shift will be just as productive as on the day shift. In all places where possible the lamps and reflectors should be periodically cleaned to obtain maximum illumination from the energy that is being consumed.

Electric furnaces are used in the manufacture of certain chemical products, such as carbon bisulphide,

phosphorus, calcium carbide, calcium cyananide, etc., and in the fixation of atmospheric nitrogen.

Heating

A field of electric heating especially adaptable to the chemical industry is that to be obtained by the application of the electric resistance type of oven heaters such as are used by the automobile industry in enameling ovens. The application may be made directly, by the installation of the heaters in rotary driers, or below horizontal refining tanks; and indirectly, in oil heat transmission systems, by installing the heaters in a heating tank of high flash point oil which is circulated through the jacket of the still or autoclave. For operations requiring long heating periods this application does away with attendance of coal-, oil- or gas-fired furnaces to heat the oil. The advantage of electric heating is the automatic control of temperature by means of pyrometer-controlled magnetic switches. A kilowatt-hour of electrical energy is equal to 3,415 B.t.u.

Transportation

Due to the fact that the majority of chemical plants require numerous buildings, and in some cases safety spacing, transportation of raw, semi-finished and finished materials becomes an important consideration. Where roadways are adjacent to all manufacturing buildings, transportation may be taken care of by horses and wagons and gasoline or electric motor trucks. Where narrow-gage or tram tracks are installed, the motive power can again be furnished by horses and gasoline or electric locomotives. The following interesting data were secured from a chemical plant that has used all three forms of motive power.

1. Two electric locomotives did the same amount of work as fifteen horses. Including maintenance of horses and wage of drivers, the total cost of transportation per operating hour with the fifteen horses was $11.75. The total cost of transportation per operating hour with the two electric locomotives, including operators, repairs, charging and miscellaneous material, was $1.60. This latter charge did not include battery replacement, but assuming at least 2 years' life of battery, the cost would be increased to only $2.20 per hour.

2. Gasoline locomotives were out of running condition 50 per cent of the time and for the hours operated cost $1.50 per locomotive-hour. The electric locomotives had a "use factor" of practically 100 per cent and cost 74 cents per locomotive-hour. Neither of these figures includes operators' wages, which were the same in both cases and the available operating time per month averaged 200 hours.

STORAGE BATTERIES FOR ELECTRIC LOCOMOTIVES

Special types of batteries are manufactured for electric locomotives. The battery should always be so mounted on the locomotive that the flat of the plate comes against the direction of motion. This assembly permits a cushioning effect of the electrolyte against the flat of the plates, and prevents displacement of plates or breakage of the rubber jars. The tray of discharged cells can be quickly lifted from the locomotive by a hand crane and replaced by a tray of charged cells.

When operating but one shift, and with only one battery charge per shift, the constant current method of battery charging can be used. But with three shifts, or several replacements per shift, it will reduce the time of charging and the consequent reduction in investment in batteries to use either the constant poten-

tial or modified constant potential methods. The two latter methods automatically control the charging rate and do away with the manual control of the charging current rate to prevent excess rise in temperature of electrolyte. Ampere-hour meters in conjunction with relays automatically cut out the battery when fully charged.

Electrolysis

Chemists as a rule are familiar with the application of direct current to electrolytic work. The electrolysis of saturated brine in concrete body cells containing graphite anodes, asbestos diaphragms and perforated sheet metal cathode plates produces chlorine gas in the anode compartment, and caustic soda liquor and hydrogen gas in the cathode compartment. Cells are connected in series and average from 3.2 volts to 4 volts per cell, depending upon the plugging of the diaphragms and the deterioration of the anodes. The energy efficiency of an electrolytic cell averages 55 to 60 per cent.

The decomposition of water to obtain oxygen and the byproduction of hydrogen is also accomplished by means of electrolytic cells. Except where water power is available the direct current is converted from alternating current by rotary converters of the booster type or by motor generator sets. Sufficient voltage range is necessary to handle the normal voltage variations of a series of cells.

Electrical Precipitation

The precipitation of dust, mist or fumes is accomplished in passing through vertical pipes by the ionization of the gases in the electrostatic field within the pipes. This electrostatic field is produced by means of wire or chain negative electrodes centered in the pipes, forming the positive electrode, the latter being grounded. A potential of 25,000 to 100,000 volts direct current is applied to the system. This high potential is secured by rectification of high potential alternating current with either mechanical disk-type commutator rectifiers or special two-electrode vacuum tubes. The ions travel with high velocity in a direction at right angles to the electrodes and impart a static charge to fume particles, causing them to be projected against the inner surface of the tubes, where they will either flow down the tubes or be rapped down. These installations have been successful in the recovery of nitric acid fumes, organic materials, potash from cement plants and the removal of sulphuric acid mist from gases from sulphur burners.

Miscellaneous Uses

Chemical laboratories have found many uses for electrical service in ovens, muffle furnaces, electrical settling, the starting of reactions by electrolysis and electrometric methods in chemical analysis. The mechanical department with an electric welding machine can cut down the cost of repairs, as equipment can be repaired without removal. With steel electrodes the bottoms of tanks can be repaired by welding while in place. The sterilization of water by ultra-violet rays has been accomplished.

Consideration of the applications of electrical service which have been shown in this article will give the chemical plant man a rough idea of the present field; but who can guess what will happen in the field of electrical application to the chemical industry in the next few years?

Wilmington, Del.

Molding Practice for Aluminum Alloys*

Aluminum Casting Alloys Are Light and Hot Short, Therefore It Is Necessary to Use Free Venting Molds and Cores Which Crush Easily — Low Gates and High Risers, Together With Free Use of Chills on Thick Sections, Necessary for Sound Casting

ALUMINUM can be cast by the same general methods used in the casting of brass and bronze, but with certain modifications dependent upon its various physical properties. The purpose of the following information is to point out where these changes in method should be made and to state in general what is considered the best practice.

MOLDING SAND

In the selection of molding sand for an aluminum foundry the texture or mechanical composition of the sand is much more important than its chemical composition. A good molding sand should be neither "close" nor "open." If it is too fine it will not be free-venting and will, therefore, prevent the escape of air, steam and gases. On the other hand, it should not be too coarse or it will fail to give a smooth and clean surface to the casting.

The sand most generally used in aluminum founding is Albany OO molding sand. The clay in this sand forms such a good natural bond that no artificial binder, such as flour, treacle, dextrin or sulphite-lees, is needed. All that is necessary is to riddle the sand through a No. 4 sieve to remove all large foreign substances, to moisten it and to mix it thoroughly; then it is ready for use. Just enough water should be added to the sand to give it the required bond; additional water only obstructs the escape of the steam generated and the gases given off by the molten metal.

No specially prepared facing sand is required. When riddled through a sieve ranging in size from No. 8 to No. 20, depending upon the casting in question, the regular molding sand makes a good facing for the pattern. Additions to the sand for the purpose of forming a smoother surface for the mold and increasing the bonding qualities of the sand are harmful, for they make the sand impervious to steam and gases. The practice of facing the pattern with good sand and using almost any kind of sand as a filler-up is a bad one. The saving realized in the cost of sand is more than offset by the loss in defective castings due to poor molds.

The usual method of putting the new sand into service is to add small quantities of it at frequent intervals to the old sand. With each additional use the molding sand loses some of its bond. The molten metal drives off the water and "kills" the clay which comes in immediate contact with it. Inasmuch as sand tempers best when it is steaming, water and new sand are usually added immediately after the castings have been shaken out.

PRINCIPLES TO OBSERVE

Careful observation of the two following characteristics of the common aluminum alloys will obviate most of the troubles of the molder: Aluminum alloys are

light, for iron or brass are two to three times as heavy; and they are brittle or "hot short" at temperatures slightly below the melting point. In casting aluminum practically every modification of the usual brass foundry practice is attributable to one or the other of these reasons, and any steps taken which provide for these peculiarities are in the right direction. A consideration of the first characteristic will explain why certain practices in ramming, venting, gating and feeding the mold employed in brass foundries cannot be used unmodified when casting aluminum. Aluminum is so light that it cannot rid itself of absorbed gases and drive off the steam as readily as brass. Observance of the second characteristic will prevent cracks in the castings due to hard cores or molds. If the cooling metal when in its "hot short" condition encounters very much resistance to further shrinkage it will almost invariably crack.

Because of the lightness of aluminum alloys the mold may be made in a snap flask which may be removed when the mold is completed. The sand should be rammed as lightly as is consistent with safe handling and pouring of the mold. Additional ramming serves only to create an impervious wall which will prevent the escape of the imprisoned air, steam and gas, forming blowholes, and producing a rough surface to the casting because the metal cannot lie close to the mold. Hard ramming is also objectionable, as it prevents the mold from giving when the metal shrinks, for it must be remembered that certain parts of the mold, as well as the cores, are called upon to give way to the metal in contraction. To help the mold to keep its shape after the flask has been removed, the outside of the mold may be rammed fairly hard, but the hard ramming should never extend to the sand immediately adjacent to the pattern. A close adherence to the principle of light ramming will probably obviate most of the aluminum molder's troubles.

The mold should be well vented for the same reason that the sand should be rammed lightly. In the case of large castings especially, the minute openings resulting from the porosity of the molding sand are an inadequate outlet for the steam and gases, and venting must be resorted to. For small castings vents are often unnecessary.

LOW GATES AND HIGH RISERS

No set rules can be laid down to govern the number, size and location of gates, for each particular casting presents a different problem. This must be left largely to the discretion of the molder, who should always bear in mind the two characteristics of aluminum alloys before mentioned. One or two general suggestions, however, may be given. A liberal fillet should always be employed where the gate connects with the casting in order to avoid drawing just beneath that point. If increasing the size of the fillet does not entirely eliminate trouble from drawing, the gate should be so

located that the unsound part of the casting caused by the draw will do the least amount of harm. If possible, it is also good practice so to locate the gate that when the mold cavity is filled with metal, the length of the path traveled will have been such that the heavy sections will have filled first and will be colder than the light sections. It is also generally true that the gate should enter the casting at a low rather than high point, for less air is imprisoned in the mold by gradually rising metal than by falling metal. Due to mechanical difficulties, however, all these suggestions are subject to a limited application.

Risers are usually attached to those parts of the casting which solidify last. The parts which first solidify draw metal from the larger, slower-cooling sections, so the latter sections must find a source of supply sufficient to provide metal for both its own shrinkage and that of the smaller fast-cooling sections. Risers are constructed to create such a source of supply. They must be so located and of such a size that they will remain molten longer than the casting. Otherwise, they simply act in the same way the small sections of the castings do, and draw metal from the large section, making matters worse rather than better. If possible, the riser should enter the casting at its highest point so that the air and dross may be forced up into the riser instead of being trapped in the casting. By increasing the height of the riser, the pressure of metal may be increased, and consequently sounder and sharper castings will result. On small castings risers are seldom necessary.

Chills may also be used as a safeguard against injurious shrinkage, especially in large castings of irregular section. Where light sections of the casting join heavy sections, uneven cooling takes place. The light section cools first and, in cooling, is fed with metal from the still liquid heavy section. When the heavy section finally cools it draws from the light section, causing sponginess and sometimes cracks in the junction between the two. To correct this tendency some means of artificial cooling must be adopted which will make the heavy section set as fast as the light section. Chills are used for this purpose, and the pieces of metal are so placed in the surface of the mold that they will come in immediate contact with the heavy section of the casting.

It will thus be seen that chills serve much the same purpose as risers, the difference lying principally in the method employed. Risers prevent sponginess and cracks in the junction between two sections by supplying the larger section with molten metal as it shrinks, while chills accomplish the same result by making the two sections cool at an equal rate. Chills are also used for other purposes. They are often employed to give a hard, smooth surface to certain parts of the casting. A harder surface than is usually produced is often necessary if a part of the casting is to be subjected to unusual wear, while a smooth surface often eliminates machining.

SOFT CORES ESSENTIAL

Cores for aluminum castings should be made as soft as is consistent with safe manipulation. Because of the "hot short" condition of alloys at high temperatures, it is particularly important that they give way to the shrinkage of the cooling metal. A good core should be hard enough to be safely handled at ordinary temperatures, but should soften and crush when sub-

jected to the intense heat of the molten metal, since the slightest resistance to the shrinkage of aluminum when it is in this fragile state will usually result disastrously.

A good core sand should consist of a mixture of sharp sand and molding sand in varying proportions, held together by some such binder as rosin, flour or core oil. The sharp sand furnishes good venting qualities to the mixture. The molding sand adds strength to the cores before they are baked and produces a smooth surface to the casting. Rosin is probably the best binder to use, for on coming into contact with the molten aluminum it softens, permitting the core to give as the casting shrinks. In some core sands a small amount of flour is used in addition to the rosin to assist in binding the mixture together until the cores are baked. The rosin has no binding power until it has first been melted and then allowed to harden. Linseed oil and various patented core oils are also successfully used as binders by some foundrymen.

A sand mixture for cores that will crush and prevent cracking is composed of the following ingredients:

Sharp sand	45	parts
Molding sand	45	"
Powdered rosin	2	"
Flour	1	"

After this mixture has been moistened to the correct degree of dampness, it is ready for use. The core should be rammed lightly and should be freely vented. This precaution is more important in the construction of the cores than of the mold proper, for, unlike the mold, the core is almost completely surrounded by the metal. The completed core should be sprayed with molasses water, baked in an oven hot enough to melt the rosin thoroughly, and then given a soapstone wash to secure a smooth finish.

Green sand cores are molded from the regular sand which is used for the mold itself, and require no binder other than water. They are skin dried with a blow torch immediately before setting in the mold. At present green sand cores are used principally for large body cores in casting automobile crankcases and oil pans. With proper development there is no reason why their use cannot be greatly extended to such parts as manifolds, bearings, flywheel housings and gear cases. They cannot be used for small cores of intricate shape for ramming up, nor in places where the core print support is limited in size or position.

Green sand cores, since they are made of the same material as the mold, have an equivalent chilling effect which promotes uniform solidification of the metal. Baked sand cores, on the other hand, have but a fraction of the heat-absorbing power of green sand, therefore induce non-uniform solidification with the resultant shrinkage crack.

The crushing strength of green sand cores is from 1 to 3 lb. per square inch, or about 1/100 that of baked sand cores. This is an important consideration in connection with the very weak condition of the metal just below the solidification point when the solid shrinkage is taking place.

DIE CASTING

The art of die casting is not new. For many years zinc, lead and tin have been successfully cast in this manner. Aluminum die castings, however, are of comparatively recent development. A copper-aluminum alloy is most frequently used with copper content running from 8 per cent to 10 per cent.

It would naturally be supposed that castings made under pressure would be dense and homogeneous. On fracture, however, it is found that only the surface or skin of the casting is dense and close-grained, while the inner structure is porous. This applies particularly to the larger castings; smaller ones can usually be cast very satisfactorily. Another cause of trouble has been the cracking of the casting due to resistance to shrinkage offered by the metallic cores, but this trouble is largely removed by the use of collapsible cores.

TEST BARS

It is important to standardize methods of testing aluminum castings in order that results obtained in one foundry may be comparable with those obtained in another, or that tests made one day may check up with those made at another time. The test specimen recommended by the Society of Automotive Engineers and the one most generally used is a cast-to-size bar ½ in. in diameter at the breaking section and filleted to a ¾ in. diameter threaded end. The fillet should not be less than ⅝ in. radius. The test bar should be cast in sand, the use of chills or artificial means of cooling is prohibited. The gage length for aluminum should be 2 in.

The American Society for Testing Materials recommends a similar bar, but machined to size rather than cast to size, in order that the diameter at the breaking section may be more accurately measured. In ordinary foundry practice the increased accuracy of the test due to machining the breaking section and threading the ends is not considered sufficient to pay for the cost of machining, and so the test bar is usually cast to size and pulled in wedge grips. Even the ideally designed and cast test specimen is not without its limitations, for it can be expected to give only approximate results for the metal in the casting which it is supposed to represent.

The test bar checks the history of the metal up to the time it goes into the mold. It gives no check whatever upon the molding variables, except when the bar is attached to the casting, when it reflects certain, but not all, of the variables, and in addition it gives no check on the design of the casting. The only way in which to secure such checks is to cut the casting up into parts and take test specimens from each part. Such an experiment will indicate considerable variations in the physical properties of the different parts, for unless molding practice and design are perfect the physical properties of a casting are bound to vary from point to point.

These variations are due to shrinkage, gating methods, the chilling effect, the personal element in foundry work and the design. When it is understood thoroughly to what an extent the physical properties of a casting are subject to control by variations in the melting conditions, the molding practice and the design, a long step will have been taken toward a better adaptation of castings to the purposes for which they are intended.

Heat-Temperature Curves of Metals

The adjoining diagrams, Figs. 1, 2 and 3, are taken from an article by J. F. Shadgen in *The Iron Age*, July 27, 1922, p. 218. In turn, that author is indebted to recent investigations by Wuest, Meuthen and Duerrer[1]

[1]"Wärmeinhalts-Temperature Kurven der technisch wichtigen Metalle"; Mitteilungen über Forschungsarbeiten, No. 204; Vereines deutscher Ingenieurs.
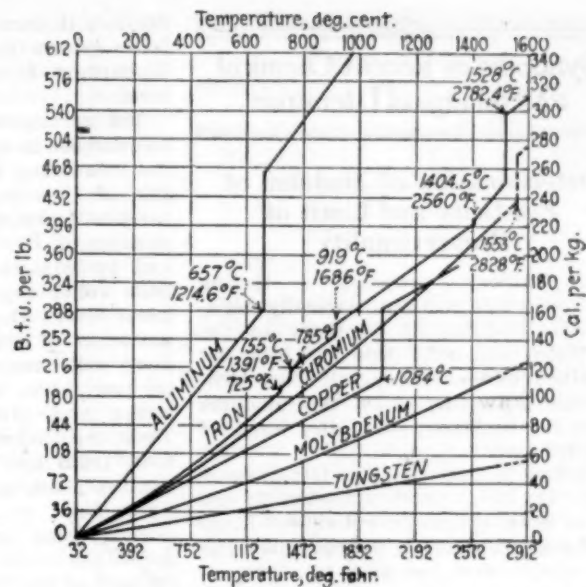

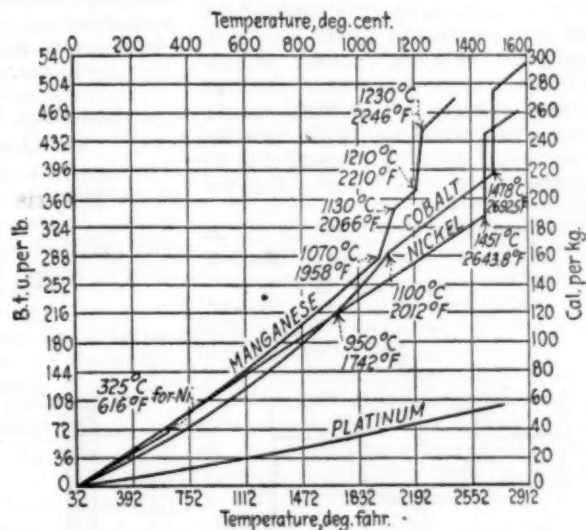FIG. 1—HEAT CONTENT OF Al, Fe, Cr, Cu, Mo AND W

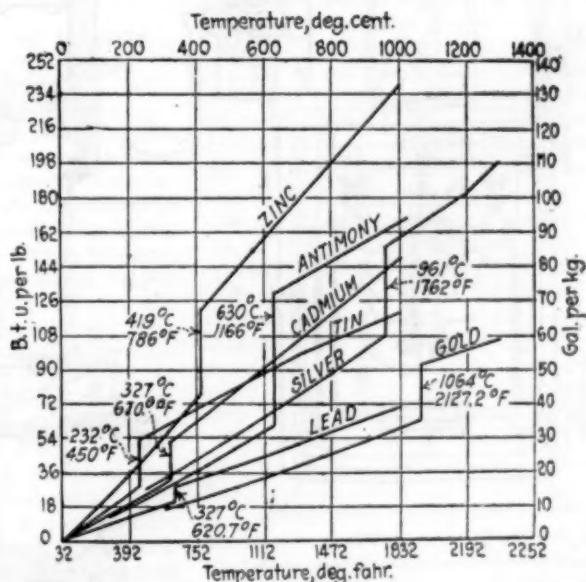FIG. 2—HEAT CONTENT OF Mn, Co, Ni, AND Pt

FIG. 3—HEAT CONTENT OF Zn, Sb, Cd, Sn, Ag, Pb AND Au

for the data from which the diagrams are drawn, and the copious tables computed. "The investigators used the purest forms of metals commercially available, and an apparatus similar to the vacuum calorimeter of

Synopsis of Recent Chemical & Metallurgical Literature

Determination of Modulus of Elasticity and Limit of Proportionality

R. Guillery[1] proposes a testing machine which will automatically register the modulus of elasticity of the specimen, and after this has been determined and checked, will then indicate the stress at which this modulus loses its constancy—i.e., the limit of proportionality.

Tension is put upon the test-piece A (Fig. 1) by a clutch attached to the piston of a hydraulic cylinder. Elongation is transferred by means of the link motion sketched at B to a proportional distention of the diaphragm at C, and is measured at a magnification of 2,000 by change in the elevation of the liquid in the attached level.

Liquid in the main cylinder is connected by a pipe to another cylinder actuating piston F, which works against a calibrated spring G, thus deflecting it an amount proportional to the stress on the test-piece A. This de-

[1]"Nouvelle machine de traction donnant la limite élastique et le module d'élasticité." *Revue de Métallurgie*, February, 1922, p. 101.

flection, in turn, is transmitted by the lever system shown at E to a second diaphragm D, also connected to the level.

The arrangements are so made that an increase in elevation of the liquid in the measuring tube caused by contraction of C is counteracted by a simultaneous decrease in level caused by expansion of D. Exact balance may be had by adjusting the position of the little roller separating the upper and lower levers at E. When this is done, variation of the tension on the test-piece will cause no change in the water level, since within the elastic limit, stress and strain are proportional. Thus, the modulus of elasticity may be read from the position of the roller against a scale attached to one of the levers E.

Everything being in adjustment, as noted, the water level is unchanged as the load on the test-piece increases. The moment the proportional limit is reached, however, the water level shows a fluctuation, and the corresponding stress can be figured from the pressure existing in the main cylinder.

Lowered Transformation in Quenched Steel

If carbon steels, containing from 0.4 to 0.9 per cent C, be cooled extremely slowly, A_1 occurs at 726 deg. C. Normal rates of cooling lower this to a narrow range at approximately 700.
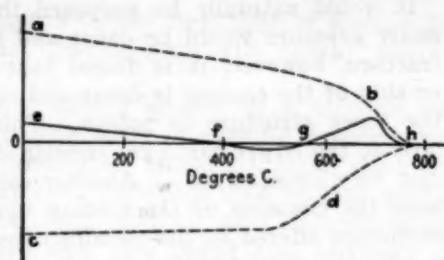

FIG. 2—TRANSFORMATION FORCES IN CHROMIUM STEEL

More speedy cooling lowers it still further and widens the range until it centers at about 550 deg. C., and the lowered transformation has been labeled Ar_1'. Quenching still more rapidly, as in jets of water at 70 deg., the lowered transformation splits, a second portion called Ar_1'' occurring at a range beginning at about 300 deg. C. or even lower. Still more drastic quenching suppresses Ar_1' entirely and lowers Ar_1'' another 100 deg. The same kind of phenomena occur in steels containing 0.9 per cent carbon and 10 per cent chromium or nickel, except, due to sluggish rates of change, they may be observed at moderate cooling speeds.

Kôtarô Honda and Tario Kikuta[*] have studied these phenomena, and conclude that Ar_1'' and Ar_1' are both merely retarded A_1 transformations—i. e., the change of austenite through martensite to pearlite. They find that if the temperature is held constant at some temperature within Ar_1', the entire transformation completes itself and Ar_1'' does not appear. In the same manner if Ar_1' is passed fairly rapidly, and the temperature held constant somewhere within Ar_1'', this lowered transformation also continues to completion—a longer time is required as is consistent with molecular inertia at such low temperatures. However, in the chromium steel, Ar_1'' does not proceed if the temperature is held constant for hours between Ar_1' and Ar_1''.

Let us assume that the forces tending to produce a transformation vary with the degree of undercooling somewhat as sketched in *ab* (Fig. 2). The retarding influences, such as viscosity, increase the inertia with falling temperature, somewhat as *cd*. The arithmetical sum is plotted in *efgh*, and for such conditions it is evident that one transformation which initiates at *h* may occur in two steps, *h* to *g*, and *f* to *o*. Between *f* and *g* the net transforming force is negative, so that a stay in this region would not suppress Ar_1''. The illustrated case conforms to chromium steel. Curve *ab* for nickel and carbon steels has sufficiently larger ordinates than *cd* so that portion *fg* lies just above the horizontal axis. Therefore, while the transformation is stepped if the cooling speed is right, it will always complete itself at any temperature if sufficient time be given. Steels with 26 per cent nickel are non-mag-

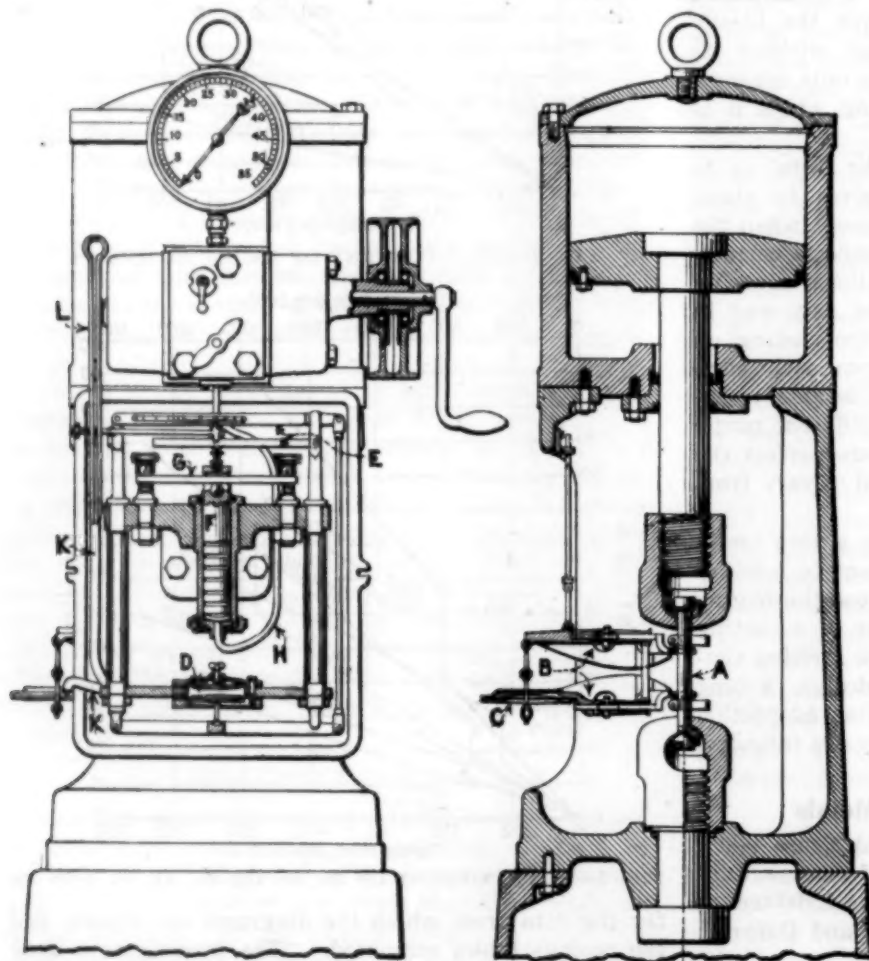[*]Fifty-ninth report of the Iron and Steel Research Institute; *Science Reports*, Imperial Tohoku University, vol. 11, p. 105. Also read before the May, 1922, meeting of the British Iron and Steel Institute.

FIG. 1—DIAGRAM OF MODULUS INDICATOR

netic at room temperature, but become magnetic in liquid air. Curves *cd* for such steels have larger ordinates at high temperatures but smaller at low, so that curve *eh* is above the horizontal axis only at very low temperatures. Exactly the opposite is true for Hadfield's manganese steel, which is non-magnetic in liquid air, but becomes magnetic after annealing at 550 deg. C.

Bureau of Mines Studies Economic Status of Carbon Black

Forty billion cubic feet of natural gas is used annually in the United States in the manufacture of carbon black, states the Bureau of Mines, which has completed a study of the subject. Carbon black is used extensively in the rubber industry, something like 20,000,-000 lb. going annually into the manufacture of automobile tires. From 10,000,000 to 12,000,000 lb. of carbon black is used annually in the manufacture of printers' ink, and from 4,000,000 to 5,000,000 lb. in the making of stove polish. The product enters also into the composition of black and gray paint, phonograph records, carbon paper, crayons, typewriter ribbons, glazed paper, tarpaulins, black leather, artificial stone and insulating materials. In normal times the United States exports probably 10,000,000 lb. of carbon black in a year.

Confusion exists in the use of the terms lampblack and carbon black. Carbon black is the fluffy, velvety-black pigment produced by burning natural gas with a smoky flame against a metal surface. In its physical characteristics it is entirely different from lampblack, which is made by burning oil or other carbonaceous material with insufficient air and collecting the smoke in settling chambers. The process of manufacture most widely used at present is the so-called channel system, in which the black is deposited on the smooth undersurface of steel channels by lava-tip burners. The mechanism is inclosed in sheet-iron buildings in order that the amount of air may be regulated.

It is generally conceded that the most important use that can be made of natural gas is for domestic purposes. Whether gas is of greater economic value for the manufacture of carbon black than for other industrial purposes is a question that will depend on the conditions existing in each locality where a large supply of natural gas is available.

The policy of the Bureau of Mines is that carbon black be made when gas is produced in isolated sections with no present or reasonably prospective market for gas being produced, when gasoline has been extracted, and when practical and modern and improved methods are used. At present there is considerable agitation for and against laws restricting the use of natural gas for the manufacture of carbon black. The matter has been the subject of considerable agitation and legislative consideration in Wyoming. The carbon-black industry has been established in Pennsyl-

vania for over 40 years, and in West Virginia for more than 20 years. The latter state still produces more than 50 per cent of the entire supply. Neither of these states has passed any laws restricting the use of natural gas for this purpose.

The carbon-black manufacturers claim that they use the best manufacturing processes that have been developed and that they produce a commodity of acknowledged utility. They have also provided a market for gas in isolated regions and in so doing have many times prevented conditions that would otherwise have resulted in waste. In certain isolated districts they have furnished small communities with natural gas whose consumption they assert was not sufficient to warrant the building of a pipe-line system.

The Bureau of Mines considers that the utilization in the manufacture of carbon black of low-pressure gas, of gas escaping into the air from natural-gas gasoline plants, gas in distinctly isolated districts, and gas in fields that have been abandoned by other gas companies on account of low pressure, is in reality often a conservation measure. It is preferable to the practice of letting the gas go to waste in the air or to plugging improperly the wells so that the gas sands can be damaged from flooding by water.

More efficient processes should be devised for the manufacture of carbon black. Thermal decomposition offers an interesting field for research as a possible means of increasing the relative efficiency of the industry. In the future it is probable that at some plants the waste heat will be utilized profitably.

The results of a study of the manufacture, properties and uses of carbon black, made by Roy O. Neal, consulting engineer, and G. St. J. Perrott, physical organic chemist, are given in Bulletin 192, just issued by the Bureau of Mines.

Vitamine Content of Canned Foods Compares Favorably With Cooked Food

A bulletin recently prepared by Dr. E. F. Kohman, of the Research Laboratory of the National Canners' Association, brings together all the research literature relative to the effect cooking has on vitamines. This research demonstrates that canned foods supply the vitamines as abundantly as the same foods cooked in the ordinary way. The vitamine content is the greatest when foods are at the proper stage of maturity for consumption and decreases when the foods are held for a period of time. Canned foods are processed in vacuum, while foods cooked on the stove are exposed to the air, which is the cause of a considerable loss of vitamine C. From the experimental evidence now available, canned foods are found to be practically as rich in vitamine A and B as the corresponding fresh raw products. In acid products, such as tomatoes and fruits, there is only a negligible destruction of vitamine C by ordinary cooking or in the canning process.

THE CHEMISTRY OF THE NON-BENZENOID HYDROCARBONS. By *Benjamin T. Brooks, Ph.D.* New York: The Chemical Catalog Co., Inc. 1922. 612 pp. 23.5x26 cm. Price $7.

"The beautiful, interesting and often facile chemistry of the benzene hydrocarbons has somewhat overshadowed the chemistry of the aliphatic open chain and cyclic non-benzenoid hydrocarbons." Dr. Brooks, in the opening sentence of the preface, thus expresses his conviction that the chemistry of the hydrocarbons has in the past been too largely aromatic chemistry. To right the balance, the author presents us with a 600-page treatise which brings together a mass of detail concerning the properties and behavior of non-benzenoid hydrocarbons, both open chain and cyclic, saturated and unsaturated. It is no mere catalog of substances and processes; the author "has endeavored to show the close relationships which hold generally throughout the chemistry of the non-benzenoid hydrocarbons and, on the other hand, to point out that the chemical behavior of the more complex hydrocarbons of the paraffin series and the alicyclic hydrocarbons cannot be assumed from the chemical behavior of a few of the simpler hydrocarbons," and he has done his task well. It is a large and varied field—paraffins, olefines, hydroaromatics and the multitudinous terpenes; petroleum refining, synthetic rubber and camphor—but each portion is ably handled with particular reference to the most modern developments.

The book should be of great value to those who are in any way dealing with non-aromatic hydrocarbons, whether from the industrial or the purely scientific standpoint. No attempt is made to consider all the complexities of such a subject as petroleum refining, but nevertheless there are several pages devoted to the pyrolysis of the paraffins and a very interesting discussion (9 pages) of the chemical aspects of certain steps in the refining, particularly the sulphuric acid treatment. The several processes for synthesizing camphor from turpentine are critically considered and clearly presented. A special chapter is devoted to the physical properties of the hydrocarbons, while another deals with their physiological action.

The organic chemist whose chief work lies in other directions will probably find the book almost as valuable as will the specialist. There are very few books or general articles which deal with the aliphatic hydrocarbons and none which can so conveniently serve as a reference book for this subject. The alicyclic compounds and terpenes have been exhaustively reviewed before, particularly by Aschan, but a great mass of difficult and complicated work has appeared since the most recent

of these special books was published. Dr. Brooks has made a special effort to include the modern work in terpene chemistry and, for example, has brought the discussion of the Wagner rearrangement up to date by including Meerwein and Lipp's work (1920). For this reason and because of the general way in which the subject has been treated, the five chapters on terpenes make an excellent textbook for a student of this difficult field. The chapter on rearrangements is of considerable theoretical interest. It is to be regretted that it does not in some way contain cross-references to other cases of rearrangements which are dealt with elsewhere in the book. In fact, a greater number of cross-references throughout the monograph would have helped in correlating the various branches of the subject which necessarily overlap.

The typography is not as good as it should be. Some of the structural formulas are very carelessly printed, the carbon "bonds" in some instances being so irregular that the meaning of the formula is almost obscured. This is, however, a relatively small point and is perhaps counterbalanced by the large number of equations and structural formulas which are given, and which, as always, are of great assistance to the reader.   JAMES B. CONANT.

ENGINEERING STEELS. By *Leslie Aitchinson*, Consulting Metallurgist of the Air Ministry of Great Britain. 397 pp. London: MacDonald & Evans. New York: D. Van Nostrand Co., 1921. Price $6.

"Engineering Steels" is written from the point of view of a mechanical engineer and designer rather than from the point of view of a metallurgist and is a valuable addition to the literature on this subject. It is clear and concise and points out the need for and importance of co-ordinating the wants of the engineer in his design with the problems of the metallurgical engineer, the heat-treating expert and the physicist. Dr. Aitchinson reviews the important factors to be met by the metallurgist in determining the proper composition for standard and special steels the heat-treatment necessary to produce the best microstructure, and the general subject of testing the steel for chemical and physical properties before applying it to the service for which it is intended.

A brief review is also given of the steel-melting processes in common use, and some of the advantages and disadvantages of each are pointed out. The author discusses the casting of the ingot, the flow of the metal under the roll, hammer or forging press and the effects of slag in the metal while being worked and its influence on steel when under stress.

The chapter on heat-treatment describes, in a concise manner, just what happens in plain carbon and alloy steels and causes them to respond to heat-treatment. The data include time-temperature cooling curves and curves showing the physical properties resulting from different drawing temperatures for different carbons in plain steel and for different alloys in alloy steels.

Photographs of special testing apparatus, macrostructures and microstructures of different classes of steel under varying conditions of manufacture and treatment are arranged in the appendix at the end of the book. This feature gives added usefulness in having much detailed data available, yet removed from the text proper.

In general, this book is a concise compilation of data on steel arranged in good order for students of steel metallurgy as well as the busy engineer who must decide quickly what material he will use and what tests he will require.   T. D. LYNCH.

THE JOURNAL OF THE INSTITUTE OF METALS. Edited by *G. Shaw Scott*, secretary. Vol. 27. The Institute, 36 Victoria St., London, S. W. I. 630 pp. Price, 31s. 6d. net.

Despite the fact that the present volume corresponds with the inauguration of Leonard Sumner, a manufacturer, as president, the most of the original papers presented are what might be called "theoretical treatises on such impractical things" as recrystallization (85 pages) equilibrium of the aluminum-zinc system, or rate of combination of copper and phosphorus. On the other hand, some manufacturers would not be altogether disappointed, since they have doubtless found that recrystallization has much to do with the permanence of their product and its immunity from season cracking. This very subject is discussed at length in the same volume by Messrs. Moore and Beckinsale, while Dr. Guy D. Bengough's recent pamphlet (designed entirely for "practical" men) on "Corrosion and Protection of Condenser Tubes" was discussed at length by many members.

An important paper on "Mechanical Properties of Nickel-Silvers," by Prof. F. C. Thompson, is also included. Abstracts from current literature taking up 220 pages complete the remainder, a balance between theory and practice or between manufacturer and user which has been the aim of the Institute since the first. How well this aim has been fulfilled was commented upon by the new president, citing the fact that during 1921, a year of greatest trade depression, the membership increased from 1,298 to 1,410. He ascribed the fact that the cessation of the war brought no drop in the widespread interest in the Institute to the "open-door" policy inaugurated during the war, when every manufacturer was driven by the press for munitions to open his plant and discuss his trade secrets with his former competitors. The value of the Institute of Metals as a common meeting ground was very apparent then, and apparently has not yet been forgotten.   E. E. THUM.
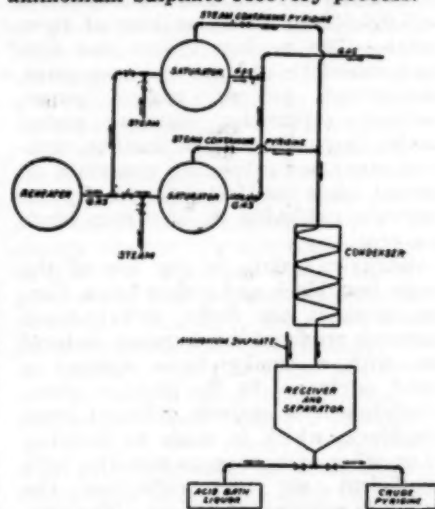
Recent Chemical & Metallurgical Patents

American Patents

Recovery of Pyridine—In the manufacture of byproduct coke and illuminating gas, pyridine bases are present in the crude gas and are finally found in the tar, ammonia liquors, ammonium sulphate, light oils, etc. Some of the higher boiling pyridine bases are separated in the tar, but the gas after the removal of the tar contains a considerable proportion of them. A large proportion of these pyridine bases are absorbed in the sulphuric acid bath along with the ammonia in the saturators as employed in the direct or semi-direct ammonium sulphate recovery process.

The object of the present invention is to recover more economically the pyridine bases from the ammonium sulphate solution and particularly to accomplish such recovery with but little interference in the regular operation of the byproduct plant. In the process they dispense with the treatment of the acid liquor bath with ammonia and recover the pyridine directly from its acid solution. While the recovery of the pyridine from a strong acid solution is difficult, it is found that pyridine can be steam distilled readily from an acid bath of low acidity. This can be accomplished readily with solutions of not more than 2 per cent acidity. The distillation of the pyridine from such solutions can be more advantageously accomplished by having the solution substantially saturated with the ammonium sulphate at its boiling point.

In the drawing is illustrated schematically the application of the present invention to the pyridine recovery in a byproduct plant employing the direct or semi-direct ammonium sulphate process. (1,414,441; Frederick W. Sperr, Jr., and Ralph L. Brown, of Pittsburgh, Pa., assignors to the Koppers Co. of Pittsburgh, Pa., a corporation of Pennsylvania. May 2, 1922.)

Nitrocellulose Stabilizer — A novel method of controlling the diphenylamine content of smokeless powder has been patented by George Rocker for E. I. du Pont de Nemours & Co. The stabilizer is introduced in the process of washing the surplus ether from the nitrocellulose colloid. A 60 per cent ethyl alcohol solution is used and is made up to contain a certain percentage of diphenylamine which is calculated according to the formula

$$y = \frac{X-B}{4.5},$$

where y equals the necessary percentage of diphenylamine in the solution, X equals the percentage of diphenylamine desired in the finished powder, and B equals the percentage of diphenylamine already in the powder. The diphenylamine-alcohol solution is calculated so that the proper amount of the stabilizer will be introduced into the powder, but no more. The excess solution is washed out by water. (1,424,212. Aug. 1, 1922.)

Gas Scrubber. — In the passage of gas or vapor through a scrubber, the back pressure created against the passage of the gas is in some cases of considerable importance. Such a case would be, for example, where a small amount of ammonia was to be absorbed in water from a large amount of gas; or again, where it is required to cool a large amount of water and the loss of water head becomes of importance.

This invention has for an object the production of a thorough contact between vapor or gas and a liquid or liquids. It is considered that by means of this apparatus, this contact can be obtained without the necessity for a high head on the liquid.

Th essential point of difference between this scrubber and other scrubbers made for a similar purpose is in the design of the diaphragm. The shell of the scrubber is composed of cylindrical sections united at flanged joints. At the bottom of each section is an inlet for gas and an outlet for scrubbing liquids. At the top of each section is an outlet for gas and an inlet for scrubbing liquids. On the inner periphery these sections are flanged to provide trough-like elements. In the interior of the section is a perforated diaphragm with its edges sealed by liquids in these trough-like elements. The perforations in the diaphragm are small and are adapted for the passage of gas without much, if any, passage of liquid.

These diaphragms are arranged so they may be set level or at an angle and means are provided for varying this angle. Liquid coming from the top is received on the diaphragm and covers it in film form. The thickness of this film depends on the angle at which the diaphragm is set and the amount of liquid supplied. The gas passes upward through the perforation and through this liquid film, producing thorough contact between the liquid and the gas. With the small perforations provided in the diaphragm, practically all the liquid on this diaphragm flows

to the liquid seal at the discharge end and thence to the section below.

It is found in practice that the passage of gas through uniform perforations, such as occur in the diaphragms described above, is substantially equal at all points. For this reason it is claimed that maximum contact of liquid and gas is obtained with the minimum amount of back pressure. (1,419,867; Wilbur G. Laird, New York, assignor to Henry L. Doherty. June 13, 1922.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Ceramics — Grains of natural or artificial corundum, or composite artificial aluminates melted in the electric furnace, are incorporated in ceramic compositions, particularly those used in the manufacture of electric apparatus such as insulators, sparking plugs, pulleys, switchboad plates, tubes, boxes and resistances. (Br. Pat. 177,160; not yet accepted. L. A. Cordenot, Rosny-Sous-Bois, France. May 10, 1922.)

Metallic Chlorides — Inorganic chlorides are obtained by passing chlorine containing sulphur chloride over a heated mixture of an oxide and carbon, the production of silicon and aluminum chlorides being particularly described. When aluminum chloride is prepared, the first product is a sublimate containing an addition product of sulphur chloride with aluminum chloride from which the two chlorides are separated by distillation, preferably under reduced pressure. The mixture of chlorine and sulphur chloride may be made by passing chlorine through an evaporator containing sulphur chloride. Alternatively, the sulphur chloride may be formed *in situ*, for example by adding sulphur compounds such as pyrites or a sulphate to the mixture of carbon and oxide. (Br. Pat. 176,811. Consortium für Elektrochemische Industrie-Ges. Munich. May 10, 1922.)

Dialkyl Sulphates — Dialkyl sulphates are obtained by heating the corresponding alcohols or ethers with alkali pyrosulphates or chlorsulphonates or mixtures thereof, and distilling *in vacuo*; or the alcohol vapor may be passed over the heated pyrosulphate. Examples of both methods are given as applied to the production of diethyl sulphate from ethyl alcohol and sodium pyrosulphate. Methyl, propyl and butyl alcohols and ethers are also specified as initial materials. (Br. Pat. 177,189; H. Dreyfus, London. May. 17, 1922.)

Phosphates — A modification of the process in which a mixture of crude phosphate, alkaline sulphate and a loosening substance is treated with hydrochloric acid gas consists in treating the mixture of phosphate and loosening substance with hydrochloric acid gas without previous admixture of alkaline sulphate. The latter is added afterward to convert the calcium chloride formed into gypsum. In this case the addition of an indifferent substance such

as sand, gypsum, infusorial earth or dry brown coal to the mixture of phosphate and loosening substance prevents caking during the course of the reaction. In an example, 100 kg. of Florida phosphate mixed with 40 kg. of crude lignite and 50 kg. of sand are submitted to the action of hydrochloric acid gas, and the product is mixed with 80 kg. of ammonium sulphate. (Br. Pat. 177,496, not yet accepted; F. Risberg, Mannheim. May 17, 1922.)

Ethylene Derivatives — These are manufactured from a gaseous mixture containing ethylene and a halogen or an acid chloride using a porous charcoal as a catalyst either with or without a halogen carrier such as chlorides of antimony, sulphur, phosphorus, etc. According to examples, the ethylene content of coal gas is caused to react with chlorine with and without antimony pentachloride, with bromine and with phosgene, forming respectively ethylene dichloride, ethylene dibromide and beta-chlorpropionyl chloride. (Br. Pat. 177,362; Bayer & Co., Leverkusen, Germany. May 17, 1922.)

Viscose — In the preparation of viscose, the caustic alkali solution is cooled to a temperature not exceeding 5 deg. C., for example, to —2 deg. C., before addition to the cellulose material. To assist the penetration of the caustic alkali solution into the cellulose, the air in the vessel in which the treatment is carried out may be evacuated or may be replaced by a gas that is soluble in or reacts chemically with the alkali solution, such as ammonia gas or sulphur dioxide. (Br. Pat. 178,152. W. P. Dreaper, London. June 8, 1922.)

Cellulose Acetate — Artificial filaments or films are prepared from cellulose acetate solutions, in particular the solutions in acetone, by coagulating the formed filament or film in a bath containing a thiocyanate such as ammonium, potassium, sodium or calcium thiocyanate. By this process the filament is of improved strength and elasticity and granulation is obviated, and in the case of filaments it is possible to employ large spinning orifices and to draw out the filaments to the fineness of natural silk. Plastifying agents such as benzyl alcohol and other additions may be made to the cellulose acetate solution. (Br. Pat. 177,868. British Cellulose & Chemical Manufacturing Co., London. May 31, 1922.)

Imitation Milk — An imitation milk, which may be concentrated or dried like cows' milk, is prepared from coconuts by extracting the endosperm with the water of the coconut. For this purpose the endosperm of fresh coconuts, preferably at the stage of ripeness at which the liquid is barely perceptible on shaking, or clean copra, is ground up with the water of the coconut, or it may be comminuted and the water afterward added. The water, with the material it has taken up, is then expressed in any known way, and the resulting liquid concentrated at a temperature not exceeding 80 deg. C. To

increase the protein and sugar content a portion of the coconut milk from which oil has been removed by decantation may be added to the liquid before concentration. (Br. Pat. 177,927. L. M. Smith, Hawaii. May 31, 1922.)

Lithopone — In making lightproof lithopone, the zinc salt solution, the baryta lye and the water used in the process are purified and clarified by producing small quantities of a purifying medium in the liquids. For example, a small quantity of an iron or aluminum salt is added, and precipitation is effected by adding a slight excess of a carbonate, phosphate or hydrate, the liquids being then boiled and filtered. The barium sulphide solution is obtained by treatment of a baryta lye, purified as described above, with sulphuretted hydrogen. (Br. Pat. 176,377. Cordes & Co. Ges., Berlin. May 3, 1922.)
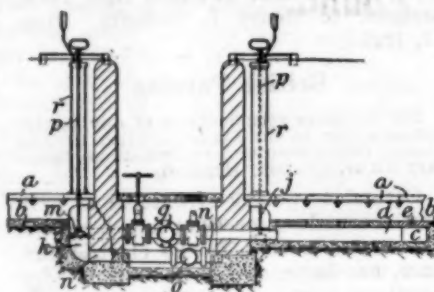
Cellulose—In the preparation of cellulose capable of forming highly viscous solutions, the lignin substances are converted by treatment with chlorine into a form soluble in cold dilute soda lye, while the cellulose remains unaltered. Straw is first boiled with dilute hydrochloric acid such as is obtained from the chlorination process. Wood is first boiled with caustic soda or milk of lime, and may be treated as shavings with chlorine diluted with an indifferent gas or applied alternately with such gas. In treating wood as chips, chlorine under pressure is used. The hydrochloric acid produced by the chlorination reaction may be reconverted into an impure chlorine and used again. (Br. Pat. 178,196. H. P. Waentig and J. O. W. Gierisch. Dresden. June 8, 1922.)

Motor Fuel—A motor fuel is produced by agitating, say, 3 to 5 lb. of calcium carbide in a pressure-resisting vessel with 9 gal. of commercial alcohol and, say, 1 gal. of acetone, and permitting the mixture to stand with occasional shaking until the acetylene is absorbed. The liquid is cleared from the bulk of the lime by carbon, manganese dioxide or other insoluble flocculating agent. A fuel of the composition specified contains over 12.5 times the volume of acetylene and 0.025 to 0.05 per cent of lime. (Br. Pat. 178,498. S. W. Blake. South Africa. June 14, 1922.)

Continuous Crystallizer—In crystallizing and separating the salts contained in a mixed solution, the solution is evaporated by being run down a sloping table, and the salts separate on the table in order of their solubilities, the least soluble being deposited first. The table, which may be cambered, has projecting edges, transverse inclined baffles and intermediate spreading baffles. The table may be mounted on trunnions so as to be turned to discharge the salts, and may be combined with other tables in triangular or other form so that, on being turned, another table surface is brought into position. The table may be heated by electric resistances extending along it or by other means, and may be covered and the water vapor evolved be drawn off and condensed. Glass

covers may be used and the heat of the sun used to effect evaporation. (Br. Pat. 178,263. T. G. Tulloch, London. June 8, 1922.)

Paper Making—In the manufacture of paper, the under side of a mass of stuff from which bleaching liquid has been partly drained is subjected to a vacuum to render the bleaching uniform throughout the mass. As shown,

the spaces between the false floors *a* and true floors *b* of a series of bins are connected to a sump by drainage channels *j*, valves *m*, ducts *k* and branches *n* of a pipe *o*. Transverse and longitudinal channels *c*, *d* in the floor *b* are connected by valve-controlled pipes with a main pipe *g* of air-exhausting apparatus. The stem *p* of each valve *m* is inclosed in a tubular pillar *r* provided with a vacuum-gage to indicate the exhaustion at the bottom of the mass of stuff in the bin. The channels *c*, *d* are covered with perforated tiles *e* preferably having upstanding branches to prevent ingress of liquor into the channel system. The channels may be omitted, pipes connected with exhausting-means then being disposed in the spaces between the floors *a*, *b*. (Br. Pat. 178,209. W. H. Salmon, Gravesend. June 8, 1922.)

Cholesterol — Crude cholesterol materials such as woolfat are purified by treating them with nitric acid, preferably with agitation and heating, for example, to 60 to 120 deg. C. The product is stated to vary from a hard waxlike substance to a highly viscous and elastic body and to be suitable for such technical applications as leather dressing, waterproofing, water- and acid-proof packing and joints, or as media in the preparations of decorative or anticorrosion solutions. (Br. Pat. 179,241. F. G. Conyers and O. Reynard, Bradford, Yorkshire. June 28, 1922.)

Purifying Hydrocarbons—Hydrocarbons are purified by treatment with acid under conditions of concentration, temperature, pressure and duration such that sulphonation is avoided and the liquid polymerization products are insoluble in the acid and remain dissolved in the hydrocarbon, from which they are recovered by distillation. In the case of sulphuric acid, the concentration is always less than 60 deg. Bé., acid of 46 to 48 deg. Bé. being preferably used with heat. Phosphoric acid may also be used. For example, heavy solvent naphtha is treated with 10 per cent of phosphoric acid of density 1.70 or of

sulphuric acid of 46 to 48 deg. Bé. at a temperature of 110 deg. C. for several hours. The acid is then drawn off, the solution neutralized and distilled in steam, yielding a viscous oil and a substance which may be used as a varnish. The treatment of xylene, benzene, toluene and light tar oil is also described. The process is also applicable to aliphatic hydrocarbons if these do not contain large quantities of aromatic derivatives. (Br. Pat. 179,610. J. Demant, Paris. July 5, 1922.)

Distilling Hydrocarbons—In distilling and cracking hydrocarbon oils by vaporizing the oil at about atmospheric pressure and compressing and condensing the vapors under pressure, the pressure is increased during the course of the distillation so that the heavier vapors coming off at the later stages are cracked by the heat generated by the compression and a uniform distillate is obtained. The still is supplied with oil from a vessel in which it is mixed with steam by a rotary stirrer to heat the oil to about 40 deg. C. The vapors generated in the still are withdrawn by a compressor and are passed through a condenser and receiver still under pressure. Uncondensed gases pass to the burners. When the evolution of vapor in the still ceases and the pressure falls below atmospheric, the temperature of the still is raised step by step and is maintained after each rise until evolution of vapor ceases. When the oil has reached a cracking temperature (about 300 deg. C.) superheated steam is passed into the still. The compressor is operated so as to maintain a pressure of about 125 lb. per sq.in. in the receiver until a temperature in the still reaches 300 deg. C., and the pressure in the receiving tank is raised about 25 lb. per sq.in. for each subsequent increase of 100 deg. C. in the still. (Br. Pat. 179,644. S. L. Gartlan and A. E. Gooderham, Toronto. July 5, 1922.)

Soya Bean Oil—To prepare inodorous and colorless oil and flour from soya beans, the beans, coarsely broken and freed from husk, are treated with an aqueous solution of organic acid, such as acetic acid or table vinegar, washed and dried. The oil is then expressed in known fashion, the temperature being kept too low to coagulate the albumen. The residue is ground to flour, which may be used either as food or in the manufacture of soap, washing powder, etc. (Br. Pat. 179,776. Y. Yamamoto and I. Mizusawa, Japan. July 5, 1922.)

Hydrogen and CO—In the process for producing hydrogen, carbon monoxide or a mixture of these gases by permitting steam or carbon dioxide or a mixture of the two to pass through an electric arc with sulphur vapor, as described in the parent specification, the metal sulphides are utilized directly in the electric furnace. By this means the metal formed also reacts, giving further quantities of hydrogen or carbon monoxide. (Br. Pat. 181,326; not yet accepted. Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiana. Aug. 2, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Suit Against Chemical Foundation Filed

Government Asks Return of German Patents and Charges Conspiracy to Form Dye Monopoly

THE Department of Justice filed a suit in equity on Sept. 8 in the United States District Court at Wilmington, Del., against the Chemical Foundation, Inc., charging a monopoly in dyestuffs and seeking the return to the Alien Property Custodian of all former German patents, trademarks and other rights held by this organization, of which Francis P. Garvan, former Alien Property Custodian, is president.

The government in its bill of complaint makes broad and general allegations of the existence of a dye and chemical monopoly in the United States, which was stimulated by the shutting off of these products from Germany during the war. It states that control of the industry was effected between a number of chemical corporations and chemists' societies. It names the National Aniline & Chemical Co., the General Chemical Co., the Solvay Process Co., the Semet-Solvay Process Co. and The Barrett Co., all of which in 1920 were combined into the Allied Chemical & Dye Corporation, and E. I. du Pont de Nemours & Co. Trade organizations given were the American Dyes Institute, the American Chemical Society, the Chemical Manufacturers' Association of the United States and the Textile Alliance.

Including exhibits of several hundred pages, the complaint covers more than five hundred printed pages, and it is attested to by Thomas W. Miller, Alien Property Custodian. The United States of America, by Attorney-General Daugherty, is listed as complainant. The solicitors for the government are Henry W. Anderson and Herman J. Galloway, special assistants to the Attorney-General, and William W. Wilson, general counsel for the Alien Property Custodian.

LISTS THE RIGHTS TRANSFERRED

The complaint states that included among the patents acquired by the Chemical Foundation were substantially all of the enemy-owned patents of any value which had not been previously disposed of, regardless of whether they related to the objects of the Foundation, such as machines for making fringes, airplane parts, telescopes, field and spectacle glasses and turbine engines. The bill charges that some of the patents acquired by the Chemical Foundation already had been granted by the Federal Trade Commis-

sion. It states that the Alien Property Custodian at the end of the Wilson Administration had transferred to the Chemical Foundation 4,813 patents, 281 applications for patents, 876 trademarks, 492 copyrights and rights under 56 contracts relating to patents for a gross consideration of about $271,000. The complaint declares that royalties amounting to $1,152,048 had accrued to the Foundation up to June 30, 1922, and that the average income from these licenses was approximately $300,000 a year.

The government declares that the records relating to these transactions were in the possession of Alien Property Custodian Garvan and his agents, who were also officers of or connected with the Chemical Foundation until the change in Administration; that many of the records were removed to the offices of the Chemical Foundation and that many of the facts stated in the bill only recently have come to the knowledge of the present Administration.

WHAT THE GOVERNMENT DEMANDS

It declares that the Foundation has now pending many suits against the government resulting from patent licenses previously issued by the Federal Trade Commission. It asks that these suits be enjoined.

A return of all properties, the removal of any cloud upon the titles caused by their sale, and an accounting and repayment of all income and profits realized by the Chemical Foundation are demanded.

Believe Soviet Activities Boost Caustic Shipments to Germany

Heavy Russian purchases of caustic soda in Germany are believed to explain, in part at least, the large movement of this commodity to Germany. Since the bulk of the movement is to Hamburg it would seem that much of the American product is being reconsigned to Russian points. If the shipments were intended for the German chemical plants, the natural destination would be Bremen, it is declared. There is reason to believe that the Russians are using this material in the manufacture of picric acid. Some anxiety is being caused by this and other evidences that the Soviet authorities are launching heavily into the manufacture of explosives.

Dye Embargo Back in the Tariff Bill

The dye and chemical control act, the so-called embargo, will be extended one year and even a second year if the President deems this necessary to protect the development of the domestic industry, according to the terms of the conference report on the Fordney-McCumber tariff bill. The conferees also agreed upon rates for coal-tar products of 50 per cent ad valorem and 7 cents per pound on intermediates and 60 per cent ad valorem and 7 cents per pound on finished dyes and chemicals, the ad valorem rates being based on American valuation.

The ad valorem rates represent an increase from 30 to 50 on intermediates and from 35 to 60 on the finished product over the House rates and are practically double the rates recommended by the Senate Finance Committee, for, while the same figures are used, the valuation basis has been changed from foreign to American. The rates are lower than those adopted by the Senate in the Bursum amendment, which carried 75 per cent plus 10½ cents per pound on intermediates and 90 per cent plus 10½ cents per pound on the finished product, the ad valorem being on American valuation.

Peril for U. S. Tariff Commission Seen in Senate Tariff Bill

Probable impairment of the usefulness of the United States Tariff Commission is seen by the Chamber of Commerce of the United States in the event of enactment of the tariff bill as passed by the Senate authorizing the commission to adjust flexible customs rates. This view was expressed in a letter sent to members of Congress by Julius H. Barnes, president of the chamber, in which it is urged that a separate governmental body be created to adjust rates.

URGES CREATION OF ANOTHER COMMISSION

In the opinion of Mr. Barnes, "the field of work to be covered in applying adjustable rates is broad enough and sufficiently varied to warrant two separate bodies—the present Tariff Commission with its statisticians, research workers and field agents to continue the highly important work of investigating and advising, a new Tariff Adjustment Board to hear evidence and to render decisions within limits set by Congress.

"If Congress adds new duties and quasi-judicial functions to the present duties of the Tariff Commission," he writes, "it will endanger the usefulness of that body."

New Bauxite Development in Tennessee

It is reported in Birmingham, Ala., that a syndicate of Chattanooga business men have organized a company for the purpose of developing large holdings of bauxite ores on Missionary Ridge. It is stated that this concern proposes building a smelter, in addition to mining the ores, for the purpose of turning the ores into billets.

The company is said to have acquired at least 1,000 acres of these ore lands; and engineering reports on the land acquired are to the effect that they are very rich in the ore from which aluminum is made.

The initial capital of the syndicate is to be $1,000,000, and a large percentage of the funds have been pledged; in fact sufficient to assure the opening of the mines and the erection of the first unit of the smelter, according to reports.

The developers of this new bauxite ore property point with enthusiasm to the fact that the electric power available is sufficient for any operations they may contemplate; and will make an effort to get their operations going in time to be with the vanguard in the new rumored developments in the automobile motor field.

Oil Consumption in July Sets Record

Consumption of crude petroleum in July was the highest on record for any month, having increased more than 51,000 bbl. as compared with June, while the daily average production decreased 15,633 bbl., the Geological Survey announces in its monthly report.

Domestic production in July aggregated 46,593,000 bbl., an average of 1,503,000 daily, compared with 45,559,000 bbl., an average of 1,518,633, in June.

Imports were estimated at 11,308,000 bbl., an average of 364,773 daily, compared with 12,182,000, an average of 406,062 bbl. daily.

Stocks held July 31 aggregated 261,478,000 bbl., or a supply of 158 days, compared with 255,817,000, or 159 days' supply so held on June 30.

Estimated consumption of domestic and imported petroleum was 51,387,000 bbl., an average of 1,657,645 daily, compared with 48,192,000, an average of 1,606,400 daily, in June.

Imperial Oil Will Build Refinery at Calgary, Canada

The Imperial Oil Co. has decided to build a large refinery at Calgary. C. O. Stillman, president, and A. M. McQueen, vice-president of the company, were in Calgary recently, looking over sites and making negotiations with the Mayor and City Commissioners for certain concessions in the event of a refinery being erected. At a meeting of the directors, held Aug. 18, the building of the refinery was approved, and the Mayor of Calgary was notified.

The refinery will be built on waste land in southeast Calgary.

Industrial Engineers to Meet in New York

Ninth National Convention of the Society to Discuss Economics of Industry

A number of subjects of general interest are included in the final program of the meeting of the Society of Industrial Engineers, which is scheduled for Oct. 18 to 20 at the Hotel McAlpin in New York. The general scheme of the discussion will be "Economics of Industry," and a number of well-known engineers and executives will contribute their ideas to the discussions of various phases of this topic. Sectional meetings for managing executives, production managers, sales managers, industrial relations directors, accountants and educators are included in the program. The international committee for the elimination of unnecessary fatigue will hold an open meeting.

A special feature will be an exhibition of factory and office equipment designed to save labor and reduce fatigue. The exhibition will be held in the winter garden adjoining the ball room in which the principal meetings will be held.

WEDNESDAY'S PROGRAM

The opening session on Wednesday afternoon, Oct. 18, will be addressed by Joseph W. Roe, president of the society, on the subject "The Relation of Economics to Industry." A. J. Lutterbach of the Palmolive Co., Milwaukee, Wis., will address the society the same evening on "The Budget and the Financial Forecast." Another paper of general interest at this session will be presented by L. W. Wallace, secretary of the Federated American Engineering Societies, on "The Importance of the Elimination of Waste to the Economic Structure."

THURSDAY AFTERNOON MEETING

Two important economic factors will be considered at the Thursday afternoon meeting, when symposiums are scheduled on the following topics: "How Can We Reduce Production Costs?" and "How Can We Keep the Worker Contented?" The annual banquet of the society is scheduled for Thursday evening, at which D. R. Dewey of the Massachusetts Institute of Technology will address the gathering on "The Relation of the Economist to Business" and Francis H. Sisson of the Guaranty Trust Company of New York will speak on "Finance and Industrial Economics."

MEETINGS ON FRIDAY

Friday morning will be given over to the sectional meetings enumerated above, at which a number of well-known speakers will discuss pertinent topics. The closing sessions on Friday afternoon will include talks by Ernest F. Dubrul, general manager of the National Machine Tool Builders' Association, on the "Economic Aspect of Production" and by A. J. Todd, director of labor, B. Kuppenheimer & Co., on "The Industrial Age."

Dye Investigation to Be Resumed Next Winter

A partial report from the special dye investigation committee of the Senate will be submitted before the present session ends, according to Senator Shortridge of California, chairman of the special committee.

Senator Shortridge declined to indicate the nature of the report. His personal attitude, however, was indicated to some extent by his statement on the floor of the Senate in July, when the dye embargo of the tariff bill was defeated, at which time, in defending the proposed embargo, he stated that not only had the investigation failed to disclose a monopoly of the dye and chemical industry of the country but that it had established the fact of "active competition."

The special committee held hearings for several weeks last spring before adjourning indefinitely. It is expected the committee will resume hearings next winter and conclude its work by clearing up a few points which were not touched in the testimony last spring.

Delay in drafting the partial report is due to absence of some members of the committee, according to Senator Shortridge. He stated that he expects to submit the report after the Dyer anti-lynching bill has been disposed of. This bill has been set as the last of the outstanding measures to be taken up at this session of Congress, according to the program announced by the Republican steering committee.

Evening Chemistry Courses Offered by City College of N. Y.

A series of evening courses in chemistry is announced by the College of the City of New York. The project has been arranged by the Evening Session Chemical Society as an opportunity for those engaged during the day to take up special subjects or to lay the foundation for a degree in chemistry. Besides the B. S. and Ch. E. degrees, a special departmental certificate is given to students who desire chemical knowledge only. To receive this certificate the student must complete the courses with an average of 80 and make a satisfactory report on some research problem. Thus the certificate indicates that the holder has a knowledge of the main branches of chemistry, a very good scholarship rating and some practice in research.

In addition to the various branches of chemistry usual in college courses the night sessions this fall will include two courses of interest to graduate and special students. Both will be under the direction of F. E. Breithut. Chemistry 159 concerns food inspection and analysis and Dr. Breithut plans to include lectures and excursions in cooperation with the Department of Health of New York.

Registration for the fall term starts Sept. 18. Further information may be obtained by writing to the Evening Session Office, College of the City of New York, Convent Ave. and 140th St.

Manufacturers' Attorney Attacks Dyestuff Duties

George Demming of Philadelphia Says Excessive Duties Prohibit Competition and Tend to Form Monopoly

"EXTORTIONATE" is the term applied to the present dye tariff rates by George Demming, attorney for a large group of Philadelphia, eastern Pennsylvania, New Jersey, Delaware and Maryland manufacturers, who will shortly appear before the House and Senate conferees in Washington to wage a vigorous fight for the reduction of the present duties.

The manufacturers who were opposed to the dye embargo are even more strongly opposed to the present tariff schedule, according to Mr. Demming, who declared that the duties were worse than the former embargo. Mr. Demming stated that Senator Smoot, who is leading the fight on the floor of the Senate for a lower dye tariff, made the following statement, which many manufacturers do not understand:

"For any foreign manufacturers of dyes to get by these rates, he would have to bring dyes to this country, give them away free of charge to the consumer and then pay the consumer money for the privilege of receiving the gift." How these words of Senator Smoot work out on a practical basis is explained by Mr. Demming as follows:

How It Works Out

"We will assume that a domestic dye, similar in quality to a foreign dye selling at 20c. a lb. abroad, is quoted in the American market for 80c. The American manufacturer, finding out that the domestic dye will not do exactly what the foreign dye does, desires to get the foreign product. He pays 20c. a lb. for the foreign product, approximately 10c. a lb. for transportation, insurance and overhead, and the dye is delivered here at a cost of 30c. Then the costs begin to mount. First the importer has to pay an ad valorem duty of 90 per cent base on the American valuation plan, which would be 90 per cent of 80c., the value of the similar American product, or a charge of 72c. per lb. Then, in addition, he pays 10½c. specific duty, or a total of 82½c. duty. Adding to this the original cost of the dye, plus transportation expenses, etc., we find that it will cost the American importer $1.12½ to get the article he wants. At this price the foreign article is naturally unable to compete with the domestic product. Thus Senator Smoot's contention is correct, and should the foreign manufacturer wish to compete with the American product, he would not only have to donate the dye, transportation and other expenses but would also have to give the importer 2½c. a lb. for taking the material."

More Than 100 Per Cent Protection

"In other words," said Mr. Demming, "the ad valorem and specific duties amount to more than 100 per cent of the value of the article under the American valuation plan, and when you protect articles to the extent of more than

100 per cent you are entering the field of extortion."

Mr. Demming asserted that in Pennsylvania manufacturers have found that the dyes, which are an absolute essential as one of their raw materials, are protected at a higher figure than that afforded their own finished products. The ordinary business man is said to want to know why the raw materials are offered this higher degree of protection than the finished manufactured product, as dyed articles made abroad, such as are manufactured in this district, are not protected by any such duties.

International Exposition and Congress on Liquid Fuel

French Government Departments Co-operating With Société de Chimie Industrielle

Final announcement of the International Exposition and Congress on liquid fuel is made by the Société de Chimie Industrielle and a cordial invitation to American representatives to attend is extended by Ambassador Jusserand. The congress will be held in Paris Oct. 4 to 15 and will be divided into two parts. During the first part of the congress discussion will be centered on the terminology of petroleum products and methods of analysis. These topics will be examined from three points of view—scientific, industrial and legislative—by three groups of specialists competent in the respective branches. The purpose of this study will be to furnish for each term the exact definition corresponding to each country and the exact description of the method of analysis employed. The congress has no intention of attempting to set international standards, but rather clearly and precisely to establish comparative tabulations, so that the present usages in all countries regarding terminology and methods may be perfectly understood by all concerned.

Following this part of the program the congress will divide into six sections in which will be brought together all the important developments and new researches in the fields of various liquid fuels. The subjects to be considered in these discussions include petroleum, shales, lignite and peat, tars and benzene, alcohol, and vegetable oils.

Arrangements for the congress have been made in co-operation with the Ministers of Commerce, Agriculture, Colonies, Public Works and Aëronautics of the French Government. Representatives of these departments will be present and participate in the discussion.

Arthur W. Thomas, 50 E. 41st St., New York City, is the secretary of the Société and is prepared to furnish further particulars to all who may be interested.

Extension of Control Act Asked by Equipment Manufacturers

Petition Sent to Senate Finance Committee Signed by One Hundred Manufacturers of Chemical Equipment

The Chemical Equipment Association through J. George Lehman, its chairman, has submitted to Senator McCumber, chairman of the Finance Committee, a petition urging favorable action on the amendment extending the dye and chemical control act, in accordance with the report and vote of the Finance Committee. In his letter of transmittal, Mr. Lehman pointed out that the Chemical Equipment Association represents the manufacturers of chemical equipment in the United States and that during the war every member of the association rendered every possible aid to the government. This resulted in expanded or relocated plants and personnel, both of which are now largely unemployed due to the uncertainty as to whether the industry will be accorded adequate protection. It is maintained that adequate protection for the chemical industry will not only assist that vital branch of our productive interests but will simultaneously assist some hundreds of co-ordinate lines to continue the advancement made in recent years, to maintain reasonable financial stability and to give wider employment to men now seeking work. The petition as submitted to Senator McCumber follows:

> The undersigned, whose business is specifically that of supplying equipment necessary to the American chemical manufacturer and industry, and believing that their close contact with the latter provides an intimate knowledge of their needs, respectfully submit for your consideration:
> 1. That the chemical manufacturer requires an endless variety and enormous volume of special equipment, the production of which in this country has progressed in step with the developing needs of the chemical manufacturer;
> 2. That the chemical equipment industry before the war was very small as compared with today;
> 3. That this equipment field represents millions of capital and thousands of employees, both now unemployed to a great extent, and, in our judgment, certain to remain so unemployed unless the American chemical industry is properly safeguarded and maintained in a flourishing condition;
> 4. Therefore, we respectfully urge that you not only support personally all just provisions for the welfare of our chemical and co-ordinate fields, but that you use your good judgment and effort in bringing your colleagues to do likewise, by voting for the amendment extending the dye and chemical control act, in accordance with the report and vote of the Finance Committee.

The petition was signed by over ninety manufacturers of all types of chemical equipment in every section of the country.

Headquarters for Chemical Engineers at Exposition

Members of the American Institute of Chemical Engineers are cordially invited to make use of *Chem. & Met.'s* booth as headquarters at the Chemical Exposition. A register will be provided and every facility afforded for bringing members of the Institute together.

Standard Oil of N. J. Says Mexican Oil Fields Are Near Exhaustion

Nation-Wide Search Must Be Made for New Fields—Future of Mexico's Oil Industry Largely Dependent on Government's Attitude

THE first era of the Mexican oil industry is drawing to a close, according to *The Lamp*, the house organ of the Standard Oil Co. of New Jersey, which gives a comprehensive survey of the past and present situation in the second largest producing country.

The production of petroleum in Mexico dates from about the year 1901, but it was not until 1911 that yield assumed such proportions that a surplus over domestic consumption was available for export. Only during the past few years has Mexican oil become a real factor in the world's markets and an important source of revenue to the government and people of Mexico.

Producing operations up to the present time have been largely confined to lands owned in fee or leased from individuals in two districts lying within the area bounded on the north by the Tamesi River; the Tuxpam River on the south; the Gulf of Mexico on the east; and on the west by an irregular line extending from the mouth of the Vinasco River through the Otontepec Mountains to the Panuco River, thence to the Tamesi. Although this area contains something like 2,470,000 acres, production has been found concentrated only in two producing districts—the Panuco field, producing very heavy, viscous oil, and the southern field, producing a somewhat lighter gravity oil.

SITUATION CRITICAL

In both the producing fields above mentioned, exhaustion of oil resources has reached such a point that the exploitation of at least two-thirds of the estimated 25,000 acres of the producing area have been abandoned. In the Panuco, or heavy oil fields, where once 125,000 bbl. per day were produced, the average is now only about 100,000. In the southern field Mexico at one time produced as much as 500,000 bbl. of light crude oil in a day. Within the last few weeks this has been reduced to less than 300,000 and is still declining rapidly.

Explorations of the past 20 years within this vast area have developed only the two producing districts named, which together contain approximately 25,000 acres, or about 1 per cent of the area explored. It is estimated that the investment in the exploration and exploitation of Mexican oil has been not less than one billion pesos, or $500,000,-000 United States currency. These figures do not take into consideration the cost of tanker fleets and foreign storage, manufacturing plants and other facilities created for the handling of Mexican oil.

The present situation is critical because the progressive exhaustion of the production has not been compensated by the exploration of new territory and the discovery and opening up of new

fields. The oil industry will have no future in Mexico unless an intensive effort to find new fields of production be undertaken and successfully prosecuted. The areas to be explored are more remote from the ports of shipment than those now producing, and the necessary development work can be carried through only by expenditure of a vast amount of new capital.

It is essential to the permanency of the petroleum industry, as known fields begin to be exhausted, that reserves for the future be discovered by the extension of operations to other prospective areas.

The conditions and circumstances which have interfered with the carrying out of this established practice in Mexico, including those conditions which have prevailed to deprive capital of the fundamental and essential insurance which it must have as to its investments and the conduct of its operations, have largely grown out of the unsettled political situation that has prevailed in Mexico for the greater part of the last 12 years.

Unfortunately both for the welfare of Mexico and of the petroleum industry, the consequences of this situation must be suffered now and in the months near at hand. The future of the oil industry in Mexico rests primarily in the hands of the government.

Paint Company Must Stop Rebate Sales Scheme

The De Soto Paint Manufacturing Co., manufacturer and distributor of paints and similar products at Memphis, Tenn., is required by recent order of the Federal Trade Commission to discontinue certain competitive methods which the commission found upon inquiry to have been followed by the company.

The commission's order is directed to respondent's practice of making an arbitrary selection from among purchasers of certain of its products, to whom rebates or bonuses are paid. Under the terms of the order, the De Soto company is required to refrain from discriminating in net selling prices by any method between purchasers of the same grade, quality and quantity of commodities, upon the basis of a classification of its customers as "professional or contracting painters" or other similar classification.

The trial of the case developed that the De Soto company gave to professional or contracting painters a certificate for each gallon of paint purchased, such certificate being redeemable at the rate of 20 cents for each gallon of colored paint and 10 cents for each gallon of white paint purchased. These certificates were not given to purchasers other than professional painters.

Societies Would Aid Power Commission

Federated American Engineering Societies Move to Improve Personnel

The work of the Federal Power Commission cannot be organized on an effective basis until the commission is given the right to employ its own personnel. The Federated American Engineering Societies is trying to obtain the necessary legislation. The Secretary of War has written to the Federated Societies pointing out the difficulties of the existing situation. An extract from Secretary Weeks' letter is as follows:

> The commission is seriously handicapped in the administration of the act on account of inability to employ its own personnel. It has had placed upon it the greatest task with respect to water powers the government has ever had, at a time when the utilization of water power is more necessary than ever before. The act made a definite **pronouncement of a national policy** in water-power development. It created a commission to carry out that policy, but it gave it no means to do so. The commission has been obliged to depend exclusively upon such assignments from the several departments as these departments were willing to spare. The departments have had their own forces cut to a point where they are unable to perform either in Washington or in the field the work required of the commission under the act; and even if they had the numbers and the funds to pay them they do not have employees with a training or an experience required for the performance of certain of the duties of the commission. As a necessary consequence the commission has been forced to omit altogether action upon important matters which the act requires of it. Furthermore, with no personnel of its own and with no control over the personnel of the departments engaged upon its work (except for the small number directly assigned to its Washington office) it is not possible to organize the work on an effective basis, or to make the most economical use of the personnel actually engaged on the commission's work or of the funds actually expended for such purposes.

In its first annual report the commission said:

"What is seriously needed in the interest of adequate administration of the act is a small organization of trained and experienced men capable of meeting intelligently the important and perplexing engineering and economic problems which are constantly arising and upon the correct solution of which will depend the value of the legislation and, in no small degree, the future of the electric power industry."

Nothing has happened since to alter the situation.

Vanderbilt University Robbed of Platinum Laboratory Apparatus

Over two thousand dollars' worth of platinum laboratory apparatus was stolen from Vanderbilt University, at Nashville, Tenn., some time between Aug. 1 and 8. The missing apparatus included six crucibles, a milk dish, two combustion boats, two evaporating dishes and a new platinum combustion tube. The university authorities are making determined efforts to prevent the thief from disposing of the booty and have broadcasted a request for information that might lead to its recovery.

The Airplane and the Boll Weevil

Calcium Arsenate to Be Spread Over Cotton Fields From the Air

The use of much larger quantities of calcium arsenate in the control of the cotton boll weevil is expected to result from the very successful experiments in dusting cotton fields by airplane. The experiments have been conducted under the direction of B. R. Coad, in charge of the laboratory of the Department of Agriculture at Tallulah, La. In a special report made by Mr. Coad and read on the floor of the House of Representatives, it was shown that with crude apparatus it was possible to poison 20 acres of cotton per hour in a much more thorough manner than ever had been attained by the equipment operated on the ground.

The air blast from the propeller of the plane disseminates the particles of the material in such a way that they filter down through the air and settle regularly over the entire plant. The amount of material needed per acre is reduced one-half.

The success of these experiments has been so decided that community poisoning is to be undertaken at once in many districts. As a result there will be much wider application of the poison and much more effectual control. In addition to the better distribution of the material when applied from the air, the whole region will be covered, thereby preventing migrations of the weevil from unpoisoned tracts, as is the case at present.

Mr. Coad in his report points out that these experiments have an important bearing on the control of insect pests which attack any field crop. Airplane dusting can be done so rapidly and save so much labor that its cost will be a very small percentage of the present cost of poisoning, particularly when the hopper and fan equipment being used on the airplane have been perfected and enlarged.

Prof. Roe of New York University to Aid Eyesight Conservationists

Election of several engineers and educators to the board of councilors of the Eyesight Conservation Council of America is announced from the headquarters of the council in New York by Guy A. Henry, general director. Engineers chosen include Prof. Joseph E. Roe, head of the department of industrial engineering in New York University, and Dr. F. C. Caldwell, professor of electrical engineering in Ohio State University.

Professor Roe is a member of the executive board of the American Engineering Council of the Federated American Engineering Societies and president of the Society of Industrial Engineers. Professor Caldwell is chairman of the committee on education of the Illuminating Engineering Society. L. W. Wallace, executive secretary of the Federated American Engineering Societies, is president of the Eyesight Conservation Council, which plans further to enlist the co-operation of the engineering profession.

Professor Roe described eye conservation, which is to be intensively carried on in the classrooms and workshops of the nation, as an important public service made possible largely through the disclosures by the Hoover Committee on the Elimination of Waste in Industry. Enormous losses, Professor Roe said, were being sustained by the nation through defective eyesight. Surveys in industrial centers and in city and rural schools are showing that economic and physical damage is being caused simply through failure of parents, teachers and factory managers to correct faults which can be remedied.

Additional Plans for Detroit Convention of Steel Treaters

In addition to the plans announced in *Chem. & Met.* for the convention of the American Society for Steel Treating and the American Drop Forging Institute, to be held in the General Motors Building at Detroit from Oct. 2 to 7, other happenings of interest have been arranged for the same period.

H. N. Taylor, president of the N. & G. Taylor Co. and president for the past 8 years of the Drop Forge Supply Association, has made arrangements for holding a meeting of the members of his association at 12:30 p.m. on Tuesday, Oct. 3, in the General Motors Building.

F. M. Waring of the Pennsylvania R.R., chairman of Committee A-1 on Steel of the American Society for Testing Materials, has called a meeting of his full committee to be held at Detroit on Oct. 5 and 6, in the Hotel Statler.

On Thursday, Oct. 5, a bronze tablet will be unveiled on the walls of the Wyandotte Public Library to the memory of those pioneers who in 1864 erected the first commercially successful bessemer steel converter on that site. This tablet is the gift of the Detroit Chapter of the American Society for Steel Treating and marks the first public recognition of the achievements of William Kelly, who made his first bessemer steel in 1847 and patented his process in 1856.

Announcement will be made during the convention of the American Society for Steel Treating of the rules governing the award of the Henry Marion Howe Medal, a gold medal to be given annually to the author of the paper considered of highest merit on any subject within the field covered by the society and commemorative of the distinguished services rendered by the late Dr. Howe.

A.C.S. Council Announces Prize for American Chemists

Announcement of a $25,000 prize, to be awarded annually to the American who makes the most notable contribution to chemical science, was one of the outstanding features of the first meeting of the council of the American Chemical Society on Sept. 4 at Pittsburgh.

American Mining Congress to Organize Southern Division

Active Support to Be Given to Plans to Push the Muscle Shoals Power Project to Completion

Active support for the completion of the Muscle Shoals, Ala., power project is being given by the American Mining Congress, which will hold a convention at Chattanooga, Tenn., on Sept. 29, for the purpose of organizing a Southern division of the organization. The Governors of the Southern States, mining operators and others have been invited to assist in the movement, which, it is claimed, will result in the creation of a great Southern mineral empire.

DEVELOPMENT OF CHEAP POWER AND TRANSPORTATION ESSENTIAL

"The most important thing in the South today is the development of cheap power and transportation," said James F. Callbreath of Washington, D. C., secretary of the American Mining Congress. "With this in view, the American Mining Congress proposes to consolidate its existing state chapters in the South into a Southern division, thus placing the entire organization of the American Mining Congress behind the completion of the Muscle Shoals project. The development of the Muscle Shoals project is essential, first, for transportation; second, for cheap power; and third, because its completion combined with the proximity of the great mineral resources of the South to the natural markets and superior supply of labor creates the possibilities of a great Southern mineral empire, which can compete with the products of any other region.

OPPORTUNITIES OF THE SOUTH

"Many mining operators in the South have never awakened to the possibility of utilizing the efficiency of large operations analogous to the development of the porphyry coppers of the West," continued Mr. Callbreath. "The widely diversified and disseminated deposits of graphite, phosphate, manganese, barytes, pyrites and other minerals in the Southern States and their successful marketing call for collective thought and co-operative action. Cheap power is a prerequisite to successful mining operations. Without highly developed transportation, successful marketing cannot be attained. The mining industry is an essential factor to national prosperity. The constructive work of the American Mining Congress in behalf of the mining industry during the past 25 years entitles it to the heartiest support, complete indorsement and active co-operation of every man interested in the industrial development of the South."

Mr. Callbreath will outline the scope and purpose of the new organization in an address before the Chattanooga meeting, which will be held at the Hotel Patten and for which preliminary arrangements are being made by Dr. Henry Mace Payne, consulting engineer of the American Mining Congress.

Water Pollution Bill Passed

Quick Action on Frelinghuysen Bill to Prohibit Discharge of Oil

The Senate on Aug. 31 passed, without debate, a bill to prevent pollution of navigable waters by the discharge of oil. The measure was introduced only the preceding day by Senator Frelinghuysen of New Jersey to replace in more simple form the several pending bills on the same subject. It was reported favorably by Senator Willis, for the Committee on Commerce, with a brief report calling attention to the indorsement of the general plan by Secretary of War Weeks and Major-General Lansing H. Beach, chief of engineers, and was adopted with only a perfecting amendment offered by Senator Lenroot of Wisconsin, being disposed of quickly between the vote on the bill for adjusted compensation for former service men and debate on one of the administration coal bills.

The measure makes it unlawful to discharge oil—including fuel oil, smudge or refuse—upon, into or under navigable waters of the United States from any vessel, excepting for the purpose of smoothing the sea in case of emergency or under such regulations as may be prescribed by the Secretary of War in such quantities as shall not be deleterious to health or fish or dangerous to property. A fine of $2,500 for violation is provided and clearance papers may be denied until the fine is paid. The act does not become fully effective until 3 months after its passage and may be suspended in time of war.

The brief report accompanying the bill set forth a letter from General Beach calling attention to the lack of legislation to control oil pollution and its need, together with excerpts of hearings on previous bills calling attention to the fire hazard and destruction of fish and vegetable life by oil on waters.

Tons of Picric Acid to Be Distributed to Farmers

The Bureau of Public Roads, United States Department of Agriculture, is making plans to release, for shipment to farmers this fall, millions of pounds of picric acid for agricultural explosive purposes, such as clearing lands of stumps, etc.

This distribution of high-grade agricultural explosives to farmers by the government is to be without cost except 7 cents per pound for drying and cartridging expense plus the cost of the freight. Originally about 12,000,000 lb. of the picric acid was available as war surplus. A considerable amount was distributed to the states for road-building purposes by the government and there now remains approximately 5,000,000 lb. to be distributed this fall. The Bureau of Public Roads urges farmers in all sections of the country who can use this explosive to apply now for it, so that the fall shipping schedules may be made up for the

states. Some of it is located at Fort Wingate, New Mexico, and an additional supply, for shipment to Eastern points, is located at Edgewood Arsenal, Maryland.

Picric acid is classed among the safest of explosives while at the same time being powerful, and for these reasons, if for no other, is ideal for blasting purposes. It also has advantages over commercial explosives, among them being that it keeps indefinitely and is not affected by heat or cold. Because of its greater cost of manufacture, it is not a competitor with commercial dynamite. It is being distributed for the purpose of increasing interest and activity in land clearing.

The Minnesota State Agricultural College reports: "We feel that picric acid has been a great benefit to the state and has done a great deal to stimulate land clearing. All reports are to the effect that its use has been highly satisfactory. The 744,000 lb. allotted to Minnesota last year was distributed to 3,511 farmers, averaging 222 lb. to the farmer. We estimate this will clear 35,000 acres of land and has made a saving of over $70,000 for the farmers of the state."

House Sidetracks Muscle Shoals

The President has authorized the transfer of certain river and harbor funds which makes available an additional $600,000 to apply on the work at Muscle Shoals. This amount insures the maximum amount of work which can be done on the project at this time and adequately bridges the period prior to Oct. 1, when the $7,500,000 appropriation becomes available.

The struggle in the House to obtain consideration of the Ford offer continues. Representative Garrett of Tennessee, the acting minority leader, forced the majority to abandon its plan for 3-day recesses. He is forcing roll calls on adjournment and resorting to all parliamentary tactics to speed the disposition of other business before the House with the idea that the majority then will be compelled to proceed to the consideration of the Ford offer.

Representative Mondell of Wyoming, the majority leader, states that he has no disposition to block the consideration of the matter, but contends that the legislative situation is such that it would be perfectly idle to call up the matter at this time.

It is possible that the House may take up Ford offer at this session, but the probabilities strongly favor the deferring of such action until the December session.

I.C.C. Rules on Shipment of Linseed-Oil Meal

The Interstate Commerce Commission has ruled that rates charged on carload shipments of linseed-oil meal from Undercliff, N. J., to Chicago, Ill., and North Hammond, Ind., are not unreasonable except as to shipments moved over the New York Central.

Personal

ARTHUR W. AMBROSE has been selected to succeed E. A. Holbrook as assistant director of the U. S. Bureau of Mines. Mr. Ambrose has been in the service of the bureau since 1917, during which time he has risen through the various grades from petroleum technologist to chief of the petroleum division of the bureau. His appointment as assistant director is an indication of the increasing importance of the bureau's petoleum work. F. B. TOUGH, who has been serving the bureau as chief supervisor of oil and gas leases, will succeed Mr. Ambrose as chief petroleum technologist. F. J. BAILEY, the assistant to the director, under a rearrangement of the work will take over a portion of the duties formerly assigned to the assistant director so as to permit Mr. Ambrose to give a portion of his time to the petroleum work. Mr. Ambrose comes originally from Lodi, Calif. His technical education was obtained at Stanford University, where he received his mining engineer's degree. Prior to his employment by the Bureau of Mines in 1917 he was in the service of the Dutch Shell and other petroleum companies. Just prior to his appointment as chief petroleum technologist, 2 years ago, he was superintendent of the petroleum experiment station at Bartelsville, Okla. Mr. Bailey is a graduate of Middlebury College, Vermont, and a graduate in law from George Washington University. He has been with the Bureau of Mines since its organization in 1910. As assistant to the director he has already had charge of a large part of the work including the Mine Safety Service.

ARDEN E. HARDGROVE, city chemist at the Akron Municipal University, Akron, Ohio, in charge of city tests, has been appointed permanent superintendent of the Akron City Hospital, succeeding Prof. Charles Bulger. He assumed his duties on Sept. 1.

Dr. KUNO B. HEBERLEIN has returned to New York after a 6 months' business trip through Europe.

GUY C. HOWARD, chemical engineer, has opened an office at 767 Stuart Building, Seattle, Wash., for consultation, investigations for industrial and financial purposes, plant design and technical supervision.

ERIC R. JETTE, who recently completed his work for the Ph.D. in Columbia University, has sailed for a year of study in Stockholm. He has an American-Scandinavian Fellowship for the year 1922-23.

J. F. SMITH has been appointed head of the research and information service of the Commercial Solvents Corporation, Terre Haute, Ind. He was formerly connected with the research department at the Buffalo, N. Y., plant of the American Aniline & Chemical Co.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Marketing Chemical Apparatus and Supplies

Reputable Manufacturers Are Facing a Serious Situation Growing Out of the Competition of Inferior, Low-Priced Goods of Both Foreign and Domestic Origin

By S. L. Redman
Central Scientific Co.

THE PAST 7 years has seen a marked change in the marketing of laboratory supplies. Prior to that time, materials were largely imported, sources were not well known and the sale of supplies was largely limited to a few firms of established reputation which held themselves strictly responsible for the quality of the products handled by them. The publicity given to chemical industry during the war, together with the ease of locating American sources of supply, led to the entrance of a number of new firms into this field, many with limited capital, limited knowledge of the business and a desire to reap quick rewards rather than to build up an institution for permanence. Having no reputation to hazard, no technical knowledge of apparatus manufacture and being desirous of obtaining goods at low costs in order to compete with established firms, some of these new dealers began to seek new sources for their supplies. The resumption of importations in 1920 favored this desire and has led to a flood of foreign apparatus being thrown on the market at low prices but of questionable quality.

This situation would have been impossible in the days when the laboratory man selected his own supplies or specified known brands or sources. The growth of the purchasing agent system, however, spreading like wildfire throughout both educational and commercial institutions, has helped to foster this condition. The purchasing agent is not always a technical man and is sometimes engaged for the purpose of making his concern's dollars stretch as far as possible. To this sort of man a burette is a burette, to be bought from the lowest bidder, and he does not care to restrict the number of bidders.

Is a Burette Just a Burette?

As a result of this situation the dealer with a reputation based on quality and service is seriously facing this dilemma: Is it necessary for him to lower his quality and skimp his service in order to secure his share of the competitive business, or can he find enough discriminating buyers to supply him with a sufficient volume of business to maintain his organization?

As an illustration of the possibility for a large difference in the price of what—to the purchasing agent—is a standard article to be bought from the lowest bidder, take the manufacture of a burette. The steps in the manufacture of a cheap and a good burette may be summarized as follows:

Cheap	Good
1. Use any stock tubing.	1. Select tubing free from striations and air bubbles.
2. Caliper only at one place for approximate diameter.	2. Caliper from end to end for uniformity of diameter.
3. Omit.	3. Check internal diameter to see that the length for the rated capacity is sufficient to bring the tenth c.c. marks at least 1 mm. apart.
4. Draw down one end and make tip or attach cheap stopcock.	4. Draw down one end and make tip or build stopcock on end or attach high-grade stopcock.
5. Put lip on other end.	5. Put lip on other end.
6. Anneal joint over flame.	6. Bake in annealing oven with pyrometer to indicate maximum temperature for 24 hours with gradual heating and cooling.
7. Select arbitrary 50-c.c. mark and point off 0 mark by rapidly running in 50-c.c. measured with another burette used as standard.	7. Carefully clean burette. Select arbitary 50-c.c. mark and point off every 5-c.c. by carefully running in portions from a certified burette, allowing full time for draining.
8. Graduate space from 0 to 50 in 500 equal linear divisions.	8. Graduate space between each two 5-c.c. marks in 50 equal linear divisions, resetting machine for each interval.
9. Wax and etch.	9. Wax and etch.
10. Melt off wax and dry.	10. Melt off wax, fill etched marks, dry and polish.
11. Omit.	11. Inspect for defective etching.
12. Wrap in paper and put in stock.	12. Wrap in paper and pack in separate carton to go in stock.

Is a burette just a burette?

How to meet this situation, which is bringing disrepute upon the entire apparatus business, is a serious problem. No reputable dealer desires to lower the quality of his merchandise, and yet his chief reward for furnishing better goods and rendering a more complete service to the laboratory man is the accusation of "profiteering." It is unfortunate that those institutions which "gambled" on the chance of securing a bargain from some "bootlegging" apparatus dealer and have been unmercifully cheated as a result do not make public their experience for the benefit of laboratory men in general. There are enough new "gamblers" each year to maintain a large number of such concerns on a very profitable basis, especially so since they are not put to the expense of developing new apparatus, or even issuing a catalog.

The best remedy in sight is apparently a long persistent campaign of education with a view to conveying to the laboratory man as much detailed information as possible about the manufacture of apparatus so that he may be able readily to detect by a brief inspection or examination fundamental

differences in quality of material, workmanship, finish and performance. This is a painfully slow process and the results may not justify the expense. In the long run it is believed that the situation will cure itself, and that after several sad experiences the laboratory worker may not only convince himself, but also his purchasing agent, that it is an axiom in competitive merchandising that you generally get what you pay for.

Chicago, Ill.

Production, Consumption and Prices in the Naval Stores Industry

TURPENTINE

More than 97 per cent of the spirits of turpentine produced in this country is from gum turpentine, the remainder from wood. Production in 1914 amounted to 27,648,939 gal., valued at $10,740,327. In 1919 the Census reported that 1,214 establishments produced 19,271,000 gal. of spirits of turpentine, valued at $21,918,100. Imports have rarely exceeded 1 per cent of the domestic output. Exports, on the other hand, formerly ranged between 15,000,000 and 20,000,000 gal., equivalent to approximately three-fifths of the domestic production. Since the war, exports have decreased to about 10,000,000 gal. The bulk of the exports go to the United Kingdom, the Netherlands, Germany and Belgium. Prices of gum turpentine were fairly stable until 1918, when a rise started that brought the price up to $2.50 per gal. in July, 1920. After a marked decline in 1921 prices are again rising and for the first quarter of 1922 have reached about $1.25 per gal.

PRODUCTION, IMPORTS AND EXPORTS OF TURPENTINE, 1914–1921

Year	Production (Gal.)	Imports (Gal.)	Exports (Gal.)
1914	27,648,939	72,679	18,900,704
1915	23,500,000	13,680	9,464,120
1916	26,750,000	20,675	9,310,268
1917	23,650,000	18,286	8,841,875
1918	17,000,000	302	3,717,093
1919	19,271,000	1,662	10,672,102
1920	....	43,385	9,458,423
1921	....	32,210	9,267,959

PRICES OF SPIRITS OF TURPENTINE, NEW YORK, 1914–1922

(Cents per Gal.)

	1914	1915	1916	1918
Jan....	46½	45½	56½	47½–48½
April..	49½–50	47½	55	42–42½
July...	49–49½	43	42	75
Oct....	48	41–41½	47	64
	1919	1920	1921	1922
Jan....	70–71	169	76	81½
April..	75	247–250	59	86½
July...	97	157½	58½	125–126
Oct....	151	139	75	....

ROSIN

The other member of the naval stores family has followed practically the same trend of production as that of turpentine. In 1914, 1,408 establishments produced 4,018,000 bbl. (280 lb. each) valued at $10,572,300. In 1919, 1,214 establishments produced 2,272,100 bbl. of rosin valued at $34,695,000. The naval stores industry is located in the south Atlantic and gulf states adjacent to the pine forests. Florida is the principal producing state, contributing about 45 per cent of

the total output. Georgia follows with 22 per cent. A very large proportion of the domestic output is for export. Prior to 1914 exports amounted to considerably over 2,000,000 bbl. Germany at that time was one of the principal consumers.

PRODUCTION, IMPORTS AND EXPORTS OF ROSIN, 1914–1921

Year	Production (Bbl.)	Imports (Lb.)	Exports (Bbl.)
1914	4,018,000	2,742,083	2,417,950
1915	3,452,000	1,505,790	1,372,316
1916	3,155,000	5,571,325	1,571,279
1917	3,630,000	129,848	1,638,590
1918	3,214,000	210,443	779,027
1919	2,272,000	96,044	1,209,627
1920	....	141,635	1,164,328
1921	....	7,115	1,001,542

PRICES OF ROSIN, WATER WHITE, 1914–1922

(Dollars per Barrel, 280 Lb.)

	1914	1915	1916	1918
Jan....	7.25–7.50	6.40	7.85	8.50
April..	6.75	6.50–6.55	6.40	8.15
July...	6.92½	6.95	7.00	12.00
Oct....	6.75	6.50	7.25	16.25
	1919	1920	1921	1922
Jan....	18.00	22.25	9.00	7.25
April..	14.50	21.75	6.00	7.25
July...	19.75	16.85	6.60	8.25
Oct....	24.00	13.25	7.40	....

Dealers in rosin seem well satisfied with the general volume of present business. Domestic consumers have shown a keener interest in the market situation and the export demand has been along moderately steady lines. Rosin B-D grades range from $6.25@$6.30 per barrel; E-I, $6.35@$6.40; K-N, $6.45@$6.65, and WG-WW, $7.80@$8.25 per barrel.

The New York Market

NEW YORK, Sept. 10, 1922.

The general tone of the chemical market during the past week was decidedly firm. Advances were recorded in several instances due to the higher cost of production resulting from the coal strike. Inquiries for home consumption were more numerous, especially for the basic commodities. A much brighter outlook has been noted in caustic soda and soda ash, with the demand for home consumption materially stronger. The previously reported firm position has been sustained in all quarters for bleaching powder. Recent buying has reduced available supplies of yellow prussiate of soda and prices reached a new high level for the year. Oxalic acid is finding a ready outlet, with prices firm. Arsenic prices remain unchanged, although demand has slackened to some extent. Bichromates have been well maintained throughout the interval and inquiries for medium-sized lots were reported in several directions. Formaldehyde prices were advanced earlier in the week, but no change in the regular routine demand has been noted.

GENERAL AND SPECIAL CHEMICALS

Acetic Acid—First-hand sales of the 28 per cent grade are heard at $2.70 per 100 lb. The 56 per cent is moving around $5.35@$5.75 per 100 lb.

Acetate of Soda—This product has been one of the features of the market. Production is greatly limited and surplus stocks have entirely disappeared.

Small quantities are reported at 7½@7½c. per lb. Round lots are almost impossible to obtain.

Bleaching Powder—Prices are quoted firm at the recent advance. Sales were reported at $1.80@$1.90 per 100 lb. in large drums, f.o.b. works. Small drums for export have brought $2.25 per 100 lb. General offerings are very limited, with the demand quite strong.

Caustic Soda—The inquiry for home consumption has been very active during the week. Small lots of standard brands are quoted at 3¾@4c. per lb. ex-store. Producers report a steady demand for contract deliveries. Export business has been somewhat dormant.

Chlorate of Soda—Leading dealers are very firm in their views for immediate shipment material and quote 6½c. per lb. as the low figure. The demand is moderately active for consuming requirements.

Formaldehyde—Large producers announced an advance in prices to 9c. per lb. in barrels for less carload quantities. Round lots are practically non-existent on the spot market.

Oxalic Acid—This market has been exceedingly strong of late and prices were again advanced to the highest level of the year. Sales at the works were reported at 17¼@17½c. per lb. Demand has been quite active and consumers showed more interest. The spot market held at the same level as works material.

Prussiate of Soda—Higher prices have been established for this material on spot. Most sellers held 24c. per lb. as an inside figure. Demand is quite active, with spot goods limited in most quarters. Shipments were quoted around 23¼@23½c. per lb. c.i.f. New York.

Soda Ash—The general tone of this market is very strong, with bag material held at $1.75 per 100 lb. and barrels at $1.90. Smaller quantities command a small premium. Producers report an active call for contract requirements.

COAL-TAR PRODUCTS

Restricted production combined with increased inquiries are chief factors in bringing about firm markets for several coal-tar products. Factors in benzol state that normal conditions are still somewhat remote, although a slight improvement in production was apparent. Spot goods are entirely nominal. The phenol market seems to be following the same strong course. No relief is in sight and while producers are not inclined to quote above 20c. per lb., they admit that future shipments are the only offerings. Spot supplies are entirely controlled by second hands and these interests are getting all they can for their holdings. Solvent naphtha has been noticeably diminished and the same condition is also true of cresylic acid. Benzoate of soda and benzoic acid are both maintained at sharp advances. Beta naphthol has been offered at 23c. per lb., with some odd lots still heard as low as 22c. The demand has improved slightly. Makers report lower prices at 20c. per lb. for aniline salts.

The St. Louis Market

St. Louis, Mo., Sept. 7, 1922.

This market has been very active for some time and in general displayed a very steady tone with some of the more important items notably strong. A rising tendency in prices was to be noted.

ALKALIS

The volume of *caustic soda* business has increased somewhat, but no change in price has as yet been reported. There are considerable stocks in the St. Louis market, for as yet the strike has caused no shortage. *Solid caustic* in 5- and 10-drum lots was quoted at $3.90 per 100 lb. delivered, with *flake* at $4.25. Very little carload business is being transacted. *Soda ash* is quoted at $2.20 in bags and $2.40 in barrels for 5- to 10-bbl. or bag quantities. *Bicarbonate of soda* has weakened slightly and is now quoted at $2.25 per 100 lb. in 1 to 5 bbl., a drop of 10c. per 100 lb. *Sal soda* is moving very slowly, but has not weakened in price; $1.65 per 100 lb. is being generally quoted on 1- to 5-bbl. lots with plenty of spot goods on hand.

GENERAL AND SPECIAL CHEMICALS

Producers in this section report a very extensive movement of *heavy mineral acids*, and prices are strong. *Carbolic acid crystals* have been moving very extensively during the past few weeks, and it is reported that the government surplus stocks are about depleted. The demand for *citric acid* is practically nil. *Oxalic acid* is still one of the prominent features of the market, with a very heavy demand and prices still on the upward flight. The demand for *ammonia water 26 deg.* has been very good and prices are firm. *White arsenic, powdered,* is reported strong with a heavy demand and supplies light, prices ruling at 8¼@9c. depending upon quantity and delivery. The *blue vitriol* market has quieted down considerably, with a freer movement. *Carbon bisulphide,* while still active, is not in as great a demand today as it was several weeks ago. *Copperas* is still on the scarcity list, and while prices remain unchanged at this time, an advance would not prove surprising. *Glycerine* has taken another advance and is now firm at 17c. in drums, with a further advance looked for. An 18c. glycerine market is to be expected before any further decline need be looked for. *Sulphur* is declining slightly and is quoted at $1.95 per 100 lb. in bags for the commercial grade. This is a decline of from 5 to 15c. per 100 lb. since our last report. *Zinc sulphate* is still very strong and going higher, with the market today at 3c. St. Louis, in carload lots; 3¼@3½c., St. Louis, in less carload lots.

VEGETABLE OILS AND NAVAL STORES

Castor oil remains firm at 14c. in drums, with quite a volume of business being transacted. *Turpentine* has advanced quite sharply and today's market is $1.26 per gal. in 5-bbl. lots or $1.32 in single barrels. *Linseed oil* is again moving in good sized quantities and is being quoted at 92c. in 5-bbl. lots, basis raw oil, and $1.02 in single barrels with the usual 2c. differential for boiled oil.

Nothing of note has happened in the market for other paint materials except that a duly expected rise in prices of *zinc oxide* has not arrived as yet, the market remaining as it was when last we reported.

The Iron and Steel Market

PITTSBURGH, Sept. 8, 1922.

The low point in production of pig iron and steel fell at the end of August, when the rate of pig-iron production was about 20,000,000 tons a year and steel mill operations were estimated at approximately 50 per cent of capacity, against a rate of close to 75 per cent late in June, when there was the heaviest operation since late in 1920.

Quite promptly upon the signing of the Cleveland agreement whereby mining of bituminous coal could be resumed under union auspices, production of pig iron and steel began to increase, the important channel to be opened involving coal to byproduct ovens and the coke to the adjoining blast furnaces. Up to date nearly if not quite a dozen blast furnaces, chiefly banked furnaces, have resumed, chiefly at Pittsburgh, in the Mahoning and Shenango valleys and in the Chicago district. With these furnaces operating in regular form, production of pig iron would be increased already by nearly 10 per cent, promising a corresponding increase in steel ingot production a very few days later.

It is a notable fact that there is not corresponding resumption of idle merchant furnaces. The merchant furnaces of the North depend chiefly upon Connellsville and West Virginia beehive coke, production of which has not materially increased, and upon surplus coke from the byproduct ovens of steel works when there is no surplus coke. The outlook for the merchant furnaces is distinctly unpromising at the moment.

NO SOFTENING IN STEEL MARKET

The increase that has occurred in operation of blast furnaces and steelmaking departments at steel plants is not a criterion that increases will continue indefinitely. Since the Cleveland agreement of Aug. 15 there has been rather rapid resumption of coal mining at union mines, but it is not certain that coal production will continue to increase to the limit of requirements. It is regarded as practically certain, indeed, that it will not, for railroad capacity will, naturally, as usual, furnish the bottle neck.

In the retrospect, a notable feature of the situation at the moment is that there is no softening in the steel market position as a result of the ending of the coal strike. Such a softening was expected in most quarters. It is true the volume of steel buying has been relatively light in the past week, but this is not traceable plainly to in- difference on the part of buyers. On the other hand it is clear that producers are reluctant to sell. Some are already sold far ahead, while those that are not have a feeling that they may be able to obtain better prices later. Presumably there are stocks of steel in the hands of some buyers, perhaps of many buyers, and it was thought in most quarters that the ending of the coal strike would be a signal to such buyers to liquidate. No such disposition is observable, thus far at least. The disposition of the average buyer, whether jobber or manufacturing consumer, is to build up stocks against the expected railroad congestion.

HIGHER PRICES FOR A NUMBER OF STEEL PRODUCTS

While no important steel price changes have occurred in the past week, the market has plainly stiffened in its general undertone. The minimum price on bars is 1.90c. and on plates and shapes 2c., these being understood to be the Carnegie Steel prices, although no official information is vouchsafed. The deliveries involved are indefinitely far ahead. The regular market, for reasonable deliveries, has been 2.25c. on all three of these products, and it is notable that some mills upon re-entering the market now are quoting this price as minimum. Plates for shipment in 2 or 3 weeks continue to bring 2.50c.

Sheets are selling at a variety of prices, depending on delivery time and the relation between mill and buyer. The leading interest is on the basis, as recently advanced, of 3.35c. for common black. Among independents there are various prices according to circumstances, 3.35c., 3.40c., 3.45c., 3.50c. and perhaps even 3.75c. Galvanized is quite uniformly 1c. above common black. Automobile sheets range from 4.70c. to 5c.

PIG IRON AND COKE

Pig iron continues to present practically a spot or prompt market. There is no selling beyond current stocks or production, as there is nothing definite as to when any merchant furnace will be able to resume. Foundry iron for Pittsburgh delivery continues to be controlled by Buffalo, the nearest point of supply, with a Buffalo price of $34, equivalent in the case of Pittsburgh delivery to an f.o.b. valley price of about $35.50. On small sales bessemer has brought $34 valley, a $2 advance in the week. Basic remains quotable at the conjectural figure of $30 valley, there being no bids or offers or any recent sales. It is related that $32 was quoted to one inquirer, who thereupon promptly withdrew the inquiry.

Connellsville coke is quotable at $11@$12 for furnace. While the furnace coke price would be quite objectionable to a furnace that has low-priced pig iron orders remaining to be filled, and would not be particularly attractive to a furnace with a clear order book, a fundamental objection to the situation is that there is not enough coke offered, all told, to enable a single furnace to build up an operation.

General Chemicals

Current Wholesale Prices in New York Market

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride	lb.		$0.38 – $0.40
Acetone	lb.	$0.13½ – $0.13½	.14 – .14½
Acid, acetic, 28 per cent	100 lbs.	2.70 – 2 80	2.85 – 3.30
Acetic, 56 per cent	100 lbs.	5.35 – 5.40	5.45 – 5.75
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	12.00 – 12.50	12.75 – 13.50
Boric, crystals	lb.	.11 – .11½	.11¾ – .12
Boric, powder	lb.	.11 – .11½	.11½ – .12½
Citric	lb.		.45 – .45½
Hydrochloric	100 lb.	1.10 – 1.20	1.25 – 1.70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½ – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg.	lb.	.06 – .06½	.06½ – .07
Nitric, 42 deg.	lb.	.06½ – .06½	.07 – .07½
Oxalic, crystals	lb.	.17½ – .17½	.17½ – .18½
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½ – .09½
Picric	lb.	.20 – .22	.23 – .27
Pyrogallic, resublimed	lb.		1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10.00 – 10.50	
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	
Sulphuric, 66 deg., tank cars	ton	15.00 – 16.00	
Sulphuric, 66 deg., drums	ton	19.00 – 20.00	20.50 – 21.00
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.00 – 20.00	
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.		.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.		.29½ – .30
Tartaric acid, imported, powdered	lb.		.30 – .31
Tartaric acid, domestic	lb.		– .30
Tungstic, per lb. of WO₃	lb.		1.00 – 1.10
Alcohol, ethyl (Cologne spirit)	gal.		4.75 – 4.95
Alcohol, methyl (see methanol)			
Alcohol, denatured, 188 proof No. 1	gal.		.34 – .35
Alcohol, denatured, 188 proof No. 5	gal.		.34 – .35
Alum, ammonia, lump	lb.	.03½ – .03½	.03½ – .04
Alum, potash, lump	lb.	.03 – .03½	.03½ – .04
Alum, chrome lump	lb.	.05 – .05½	.05½ – .06
Aluminum sulphate, commercial	100 lb.	1.50 – 1.65	1.70 – 2.25
Aluminum sulphate, iron free	lb.	.02½ – .02½	.03 – .03½
Aqua ammonia, 26 deg.,drums(750 lb.)	lb.	.06½ – .07½	.07½ – .08
Ammonia, anhydrous,cyl.(100-150 lb.)	lb.	.30 – .30½	.30½ – .31
Ammonium carbonate, powder	lb.	.08½ – .08½	.09 – .09½
Ammonium nitrate	lb.	.06 – .06½	.06½ – .07½
Amylacetate tech	gal.		2.25 – 2.35
Arsenic, white, powdered	lb.	.08½ – .09	.09½ – .09½
Arsenic, red, powdered	lb.	.12 – .12½	.12½ – .13
Barium carbonate	ton	61.00 – 62.00	63.00 – 66.00
Barium chloride	ton	85.00 – 88.00	89.00 – 95.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.07½ – .07½	.08 – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .04½
Blanc fixe, dry	lb.	.04 – .04½	
Blanc fixe, pulp	ton	45.00 – 55.00	
Bleaching powder	100 lb.	2.00 – 2.10	2.15 – 3.25
Blue vitriol (see copper sulphate)			
Borax	lb.	.05½ – .05½	.06 – .06½
Brimstone (see sulphur, roll)			
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	2.35 – 2.40	2.45 – 2.50
Calcium carbide	lb.	.04½ – .04½	.05 – .05½
Calcium chloride, fused, lump	ton	22.00 – 23.00	23.50 – 27.00
Calcium chloride, granulated	lb.	.01½ – .01½	.02 – .02½
Calcium peroxide	lb.		1.40 – 1.50
Calcium phosphate, tribasic	lb.		.15 – .16
Camphor	lb.		.83 – .85
Carbon bisulphide	lb.	.06 – .06½	.06½ – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.		.60 – .75
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chalk, precip.—domestic, light	lb.	.04½ – .04½	
Chalk, precip.—domestic, heavy	lb.	.03½ – .03½	
Chalk, precip.—imported, light	lb.	.04½ – .05	
Chlorine, gas, liquid-cylinders(100 lb.)	lb.	.05 – .05½	.05½ – .06
Chloroform	lb.		.25 – .32
Cobalt oxide	lb.		2.00 – 2.10
Copperas	ton	20.00 – 22.00	23.00 – 30.00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.		.58 – .60
Copper sulphate, crystals	100 lb.	6.25 – 6.50	6.60 – 6.75
Cream of tartar	lb.		.23 – .25
Epsom salt (see magnesium sulphate)			
Ethyl acetate com. 85%	gal.		.65 – .70
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.		.90 – .95
Formaldehyde, 40 per cent		.09 – .09½	.09½ – .10
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	
Fullers earth—imported powdered—net ton		30.00 – 32.00	
Fusel oil, ref.	gal.		2.75 – 2.90
Fusel oil, crude	gal.		1.55 – 1.75
Glauber's salt (see sodium sulphate)			
Glycerine, c. p. drums extra	lb.		.17 – .17½
Iodine, resublimed	lb.		4.20 – 4.25
Iron oxide, red	lb.		.12 – .18
Lead acetate, white crystals	lb.		.10½ – .11½
Lead arsenate, powd	lb.	.13 – .13½	.13½ – .14½
Lead nitrate	lb.		.15 – .20
Litharge	lb.	.07½ – .08	.08½ – .09
Magnesium carbonate, technical	lb.	.06 – .06½	.06½ – .07½
Magnesium sulphate, U. S. P.	100 lb.	2.00 – 2.25	2.30 – 2.50
Magnesium sulphate, technical	100 lb.		1.00 – 1.80
Methanol, 95%	gal.		.57 – .58
Methanol, 97%	gal.		.59 – .60
Nickel salt, double	lb.		.11 – .11½

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Nickel salt, single	lb.		.12 – .12½
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.		.40 – .45
Phosphorus, yellow	lb.		.30 – .35
Potassium bichromate	lb.	.10½ – .10½	.11 – .11½
Potassium bromide, granular	lb.		.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80-85%	lb.	.05 – .05½	.05½ – .06
Potassium chlorate /powdered and crystals	lb.	.06½ – .07	.07½ – .08
Potassium cyanide	lb.		.55 – .57
Potassium hydroxide (caustic potash)	100 lb.	5.50 – 5.75	6.00 – 6.25
Potassium iodide	lb.		3.20 – 3.35
Potassium nitrate	lb.	.06½ – .06½	.07 – .08
Potassium permanganate	lb.	.14½ – .15	.15½ – .16
Potassium prussiate, red	lb.		.95 – 1.00
Potassium prussiate, yellow	lb.	.35 – .35½	.35½ – .36
Rochelle salts (see sodium potas. tartrate)			
Salammoniac, white, granular	lb.	.06½ – .06½	.06½ – .07
Salammoniac, gray, granular	lb.	.07½ – .08	.08½ – .08½
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	18.00 – 21.00	
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.60 – 1.67	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.75 – 1.80	1.85 – 2.35
Soda ash, dense, in bags, resale	100 lb.	1.85 – 1.90	1.95 – 2.40
Sodium acetate	lb.	.07½ – .07½	.07½ – .08
Sodium bicarbonate	100 lb.	1.75 – 1.85	1.90 – 2.30
Sodium bichromate	lb.	.07½ – .07½	.08 – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04½	.04½ – .05½
Sodium chlorate	lb.	.06½ – .06½	.07 – .07½
Sodium chloride	long ton	12.00 – 13.00	
Sodium cyanide	lb.	.19½ – .21	.21½ – .25
Sodium fluoride	lb.	.09½ – .10	.10½ – .10½
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.40	3.75 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.70 – 3.75	3.80 – 4.00
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.80 – 3.90	4.25 – 4.40
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.02½ – .03	.03½ – .03½
Sodium nitrite	lb.	.08½ – .08½	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04½ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.		.18 – .21
Sodium prussiate, yellow	lb.	.23½ – .23½	.24 – .24½
Sodium silicate, (40 deg. in drums)	100 lb.	.80 – 1.00	1.05 – 1.25
Sodium silicate, (60 deg. in drums)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals(glaubers salt) 100 lbs.		.90 – 1.00	1.05 – 1.50
Sodium sulphide,fused,60-62 per cent(conc.)	lb.	.04 – .04½	.04½ – .05
Sodium sulphite, crystals	lb.	.03½ – .03½	.03½ – .04½
Strontium nitrate, powdered	lb.	.09½ – .10	.10½ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 – 20.00	
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.		2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	2.00 – 2.15	2.20 – 2.70
Talc—imported	ton	30.00 – 40.00	
Talc—domestic powdered	ton	18.00 – 25.00	
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.		.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14½ – .15½
Zinc chloride, gran.	lb.	.05½ – .06	.06½ – .06½
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08½ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$1.00 —	$1.05
Alpha-naphthol, refined	lb.	1.10 —	1.15
Alpha-naphthylamine	lb.	.28 —	.30
Aniline oil, drums extra	lb.	.15 —	.17
Aniline salts	lb.	.20 —	.22
Anthracene, 80% in drums (100 lb.)	lb.	.75 —	1.00
Benzaldehyde U.S.P.	lb.	1.30 —	1.35
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 —	.35
Benzene, 90%, in drums (100 gal.)	gal.	.28 —	.32
Benzidine, base	lb.	.85 —	.95
Benzidine sulphate	lb.	.80 —	.85
Benzoic acid, U.S.P.	lb.	.70 —	.75
Benzoate of soda, U.S.P.	lb.	.53 —	.55
Benzyl chloride, 95-97%, refined	lb.	.25 —	.27
Benzyl chloride, tech	lb.	.20 —	.23
Beta-naphthol benzoate	lb.	3.75 —	4.00
Beta-naphthol, sublimed	lb.	.50 —	.55
Beta-naphthol, tech	lb.	.23 —	.25
Beta-naphthylamine, sublimed	lb.	1.50 —	1.60
Carbazol	lb.	.75 —	.90
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 —	.15
Ortho-cresol, in drums (100 lb.)	lb.	.16 —	.18
Cresylic acid, 97-99%, straw color, in drums	gal.	.56 —	.65
Cresylic acid, 95-97%, dark, in drums	gal.	.51 —	.58
Dichlorbenzene	lb.	.06 —	.09
Diethylaniline	lb.	.65 —	.70
Dimethylaniline	lb.	.32 —	.34
Dinitrobenzene	lb.	.20 —	.22
Dinitrochlorbenzene	lb.	.21 —	.22
Dinitronaphthalene	lb.	.30 —	.32
Dinitrophenol	lb.	.32 —	.34
Dinitrotoluene	lb.	.22 —	.24
Dip oil, 25%, car lots, in drums	gal.	.24 —	.26
Diphenylamine	lb.	.54 —	.56
H-acid	lb.	.75 —	.80
Meta-phenylenediamine	lb.	.90 —	1.00
Monochlorbenzene	lb.	.10 —	.11
Monoethylaniline	lb.	1.00 —	1.20
Naphthalene crushed, in bbls.	lb.	.06 —	.06½
Naphthalene, flake	lb.	.06½ —	.07
Naphthalene, balls	lb.	.07½ —	.08
Naphthionate of soda	lb.	.58 —	.65
Naphthionic acid, crude	lb.	.65 —	.70
Nitrobenzene	lb.	.10 —	.12
Nitro-naphthalene	lb.	.30 —	.35

Nitro-toluene	lb.	$0.15 —	$0.10
N-W acid	lb.	1.15 —	1.30
Ortho-amidophenol	lb.	2.10 —	2.15
Ortho-dichlor-benzene	lb.	.17 —	.20
Ortho-nitro-phenol	lb.	.75 —	.77
Ortho-nitro-toluene	lb.	.10 —	.13
Ortho-toluidine	lb.	.12 —	.14
Para-amidophenol, base	lb.	1.20 —	1.25
Para-amidophenol, HCl	lb.	1.25 —	1.30
Para-dichlorbenzene	lb.	.17 —	.20
Paranitroaniline	lb.	.72 —	.80
Para-nitrotoluene	lb.	.55 —	.65
Para-phenylenediamine	lb.	1.55 —	1.60
Para-toluidine	lb.	.85 —	.90
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.23 —	.25
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.50 —	1.55
Resorcinol, pure	lb.	2.00 —	2.10
R-salt	lb.	.55 —	.60
Salicylic acid, tech., in bbls.	lb.	.25 —	.27
Salicylic acid, U. S. P	lb.	.29 —	.30
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.27 —	.32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

All quotations same as previous report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$6.25 —	$6.30
Rosin E-I	280 lb.	6.35 —	6.40
Rosin K-N	280 lb.	6.45 —	6.65
Rosin W. G.-W. W	280 lb.	7.85 —	8.40
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	1.23 —	1.24
Wood turpentine, steam dist	gal.	1.15 —	....
Wood turpentine, dest. dist	gal.	1.12 —	.70
Pine tar pitch, bbl	200 lb.	—	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	—	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.38 —	....
Rosin oil, second run	gal.	.41 —	....
Rosin oil, third run	gal.	.48 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.00
Pine oil, pure, dest. dist	gal.		.95
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr.1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N. Y., double bags	100 lb.	3.80 —	3.85
Blood, dried, f.o.b., N. Y	unit	4.60 —	....
Bone, 3 and 50, ground, raw	ton	42.00 —	44.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate of soda	100 lb.	2.40 —	2.45
Tankage, high grade, f.o.b. Chicago	unit	4.50 —	4.60
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	4.00
Tennessee, 78-80%	ton	7.00 —	8.00
Potassium muriate, 80%	ton	33.00 —	34.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Prices remain unchanged.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.12½ —	$0.13
Castor oil, AA, in bbls.	lb.	.13 —	.13½
China wood oil, in bbls.	lb.	.12½ —	.12½
Coconut oil, Ceylon grade, in bbls.	lb.	.08½ —	.08½
Coconut oil, Cochin grade, in bbls.	lb.	.09 —	.09½
Corn oil, crude, in bbls.	lb.	.10½ —	.10½
Cottonseed oil, crude (f. o. b. mill)	lb.	.06½ —	.07
Cottonseed oil, summer yellow	lb.	.09 —	.09½
Cottonseed oil, winter yellow	lb.	.10 —	.10½
Linseed oil, raw, car lots (domestic)	gal.	.88 —	.88½
Linseed oil, raw, tank cars (domestic)	gal.	.83 —	.84
Linseed oil, boiled, in 5-bbl lots (domestic)	gal.	.90 —	.91
Olive oil, denatured	gal.	1.15 —	1.17
Palm, Lagos	lb.	.06½ —	.07
Palm, Niger	lb.	.06 —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09½ —	.09½
Peanut oil, refined, in bbls.	lb.	.12 —	.12½
Rapeseed oil, refined in bbls.	gal.	.81 —	.82
Rapeseed oil, blown, in bbls.	gal.	.87 —	.88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast.	lb.	.09½ —	....

FISH

Light pressed menhaden	gal.	$0.53 —	....
Yellow bleached menhaden	gal.	.54 —	.55
White bleached menhaden	gal.	.56 —	.57
Blown menhaden	gal.	.61 —	....
Whale Oil, No. 1, crude, tanks, coast	gal.	.45 —	.48

Miscellaneous Materials

Quotations same as previous report.

Refractories

Prices remain unchanged.

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.10 —	10½
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.10½ —	.11
Ferromanganese, 78-82% Mn, domestic	gross ton	67.50 —	69.00
Spiegeleisen, 19-21% Mn	gross ton	36.00 —	....
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	1.85 —	2.00
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	58.00 —	60.00
Ferrosilicon 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.42½ —	.45
Ferro-uranium,35-50% of U,per lb.of U content	lb.	6.00 —	......
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.50 —	4.00

Ores and Semi-finished Products

Prices remain quotably unchanged.

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb.
Copper, electrolytic	14.00
Aluminum, 98 to 99 per cent	18.00-18.50
Antimony, wholesale lots, Chinese and Japanese	5.20-5.25
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32.00-33.00
Nickel, ingot and shot, resale	30.00-31.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	32.625
Lead, New York, spot	5.90
Lead, E. St. Louis, spot	5.55
Zinc, spot, New York	6.55-6.60
Zinc, spot, E. St. Louis	6.20-6.25

OTHER METALS

Silver (commercial)	oz.	$0.69½
Cadmium	lb.	1.20-1.25
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99 per cent	lb.	1.15@1.25
Platinum	oz.	$118.00
Iridium	oz.	Nominal
Palladium	oz.	55.00@60.00
Mercury	75 lb.	65.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.00
Copper bottoms	30.00
Copper rods	19.75
High brass wire	18.75
High brass rods	16.75
Low brass wire	19.60
Low brass rods	20.25
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	24.75
Seamless high brass tubing	22.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

Copper, heavy and crucible	11.00@11.25
Copper, heavy and wire	10.50@10.75
Copper, light and bottoms	8.50@ 8.75
Lead, heavy	4.50@ 4.75
Lead, tea	3.25@ 3.50
Brass, heavy	5.50@ 5.75
Brass, light	5.00@ 5.25
No. 1 yellow brass turnings	5.50@ 5.75
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	$3.04	$2.70
Soft steel bars	2.94	2.60
Soft steel bar shapes	2.94	2.60
Soft steel bands	3.74	3.20
Plates, ½ to 1 in. thick	3.04	2.70

Industrial
Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Lehigh Portland Cement Co., Allentown, Pa., has preliminary plans in progress for the construction of a new cement mill on a tract of land at East Birmingham, comprising about 250 acres, acquired a number of months ago. The plant will consist of a number of buildings to provide for a capacity of approximately 1,000,000 bbl. per annum, and is estimated to cost in excess of $600,000.

BIRMINGHAM—The McWane Cast Iron Pipe Co., Birmingham, has plans nearing completion for the construction of a new foundry at East Birmingham, on site recently acquired. The works will comprise a number of buildings, to be equipped for the production of about 8,000 ft. of small-sized pipe per day, and will give employment to about 150 men. It is expected to commence work within the next 30 days, and to have the plant ready for service early in the coming year. It will cost in excess of $85,000.

California

NATIONAL CITY—The Jet Oil Refining Co. has commenced the construction of a new refinery on local site, and plans to have the plant ready for machinery installation at an early date. It will be equipped for the production of lubricating oils.

ANAHEIM—The Anaheim Sugar Co. has awarded a general contract to G. E. Fickette, 638 South Western Ave., Los Angeles, for the construction of a new 5-story reinforced-concrete building at its plant, 45x260 ft., estimated to cost about $160,000.

ALHAMBRA—The C. F. Braun Co., 604 Mission St., San Francisco, manufacturer of heating equipment, will commence the immediate construction of a 1-story foundry, at Shorb near Alhambra, in connection with a new works at this location, to cost about $65,000.

NATIONAL CITY—The California Gypsum Co. has plans nearing completion for the construction of a new plant on ocean front property, recently acquired, for the manufacture of gypsum blocks and other kindred products. It is estimated to cost in excess of $50,000.

Florida

BRADENTOWN—The Manatee County Fertilizer Co. has awarded a contract to J. C. Walden, Bradentown, for the construction of a new plant on local site. The main building will be 60x108 ft. The plant will have an initial output of approximately 100 tons of commercial fertilizer. J. H. Humphries is president.

Georgia

ROME—The B. Mifflin Hood Brick Co., Atlanta, has plans in progress for extensions and improvements in the plant of the Rome Fireproofing Co., recently acquired. The work will cost about $75,000, including new equipment. The company has also purchased a large tract of clay deposits in the vicinity of the Rome plant, and proposes extensive development.

CAIRO—The Farmers' Co-operative Cane Syrup Association is having plans prepared for the construction of a local plant with initial daily capacity of about 10,000 bbl.; an extensive storage works will also be built.

CAMILLA—The J. P. McRee Turpentine Co., recently organized with a capital of $50,000, has preliminary plans under consideration for the establishment of a local plant for the manufacture of turpentine, rosin and kindred products. J. P. McRee heads the company.

Idaho

MACKAY—The Republic Consolidated Mining & Refining Co., recently organized with a capital of $3,000,000, has plans in progress for the construction of a new concentrating mill and cyanide plant at its properties in

this section. A hydro-electric power plant will also be constructed. W. P. Barton is in charge. The project will cost about $150,000.

Illinois

CHICAGO—The National Paint & Wall Paper Co., care of Clarence Hatzfield, 7 South Dearborn St., architect, is completing plans for the construction of a new 1-story and basement plant, 50x105 ft., at 4317 Grand Ave. Bids will be asked at once.

PULLMAN—The Pullman Foundry Co. will soon commence the construction of a new 1-story foundry, 300x500 ft., to cost about $40,000, exclusive of equipment. Plans have been completed by Frank D. Chase, 645 North Michigan Ave., Chicago, architect and engineer.

Indiana

SPEED—The Louisville Cement Co., Louisville, Ky., has work under way on the rebuilding of its local cement-manufacturing plant, destroyed by fire early in July. It is proposed to increase the capacity at the new plant from 1,800 bbl. per day, the output of the former mill, to 2,500 bbl. per day. All equipment will be electrically operated. The new mill will cost close to $300,000, and is expected to be ready for service at an early date.

Louisiana

KENTWOOD—The Chamber of Commerce is perfecting plans for the establishment of a local mill for the manufacture of paper and pulp products. It is purposed to organize a company to operate the plant. H. A. Addison, secretary, is in charge.

BOSSIER CITY—The Louisiana Oil Refining Corp., Shreveport, is arranging for the early operation of its new plant here, now nearing completion, for the production of grease and lubricating oils. The works will have an initial capacity of about 9,000 lb. of grease and 250 bbl. of lubricating oil per day. It is proposed at a later date to extend the works, which now represents an investment of about $30,000.

Maryland

BALTIMORE—The city water department will commence preliminary work at once for an addition to the municipal water-filtration plant at Montebello, estimated to cost about $1,500,000. It is planned to award contracts for different features of the project, including machinery, by the close of the year.

Massachusetts

WATERTOWN—The Hodd Rubber Co., Nichols Ave., has awarded a general contract to William H. Illiffo, Bailey Rd., for the construction of a 2-story addition to its plant, 96x200 ft., to cost about $75,000.

WORCESTER—The Norton Co., manufacturer of abrasive products, will commence the immediate construction of a new 4-story building at its plant, 50x125 ft. Steel storage tanks and other operating equipment will be installed.

HAVERHILL—Fire, Aug. 19, destroyed one of the buildings at the plant of the Haverhill Box Board Co., manufacturer of paper products, with loss approximating $100,000.

CAMBRIDGE—The Cambridge Rubber Co., 748 Main St., will commence the immediate construction of a new 4-story plant, 83x104 ft. A general contract for the work has been let to the Scully Co., Cambridge.

Michigan

BAY CITY—The Laetz Foundry Co. is planning for the early occupancy of its new local plant, now nearing completion. It will be used for the production of a general line of metal castings.

MONROE—The new plant of the Republic Glass Co., now in course of construction, will be equipped to give employment to about 150 persons, and this working force will be increased at a later date. It is expected to have the works ready for service late in October. The company has estab-

lished general offices at 207 South Macomb St. Manuel Llera is president; and J. H. Williams, secretary and treasurer.

Missouri

COLUMBIA—The City Council is arranging for the purchase of the artificial gas plant of the Columbia Gas Co., to be operated in the future as municipal property. It is planned to make extensions and improvements. Bonds for $100,000 are being arranged.

Montana

GREAT FALLS—The Silver Dyke Mining Co., operating at Hiehart, near Great Falls, is planning for the erection of a new concentrating plant, with daily capacity of about 250 tons.

New Jersey

NEWARK—The Alcohol Products Co., Blanchard St. and the Passaic River, has awarded a contract to Fred Kilgus, Inc., 13 South 6th St., for the erection of a 1-story plant addition, 40x145 ft. Work will be commenced at once.

OLD BRIDGE—The local plant of the Brookfield Glass Co., has been acquired by new interests, represented by William J. Burke, 99 Nassau St., New York, attorney, which plan to operate the works. The new owners are said to be organizing a company to manufacture a line of glass specialties, and will take immediate possession of the property.

CEDAR GROVE—The Department of Streets and Public Improvements, City Hall, Newark, is planning for the construction of a 1-story chemical laboratory, 26x48 ft., to cost about $20,000, for testing work in connection with the city waterworks at Cedar Grove. The Bureau of Water, John A. Foulks, engineer, is in charge.

New York

LONG ISLAND CITY—The A. C. Horn Co., Bodine and Hancock Sts., manufacturer of waterproofing products, will commence the immediate erection of a 3-story addition to its plant. Plans have been prepared by William Schoen, 507 5th Ave., New York. A. C. Horn is president.

ROCHESTER—Fire, Aug. 22, destroyed a portion of the tankage department of the Monroe County Oil Co., with loss estimated at about $15,000. It will be rebuilt.

ELMIRA—The Elmira Water, Light & Railroad Co., Heulett Bldg., will commence the immediate erection of a new artificial gas-manufacturing plant, estimated to cost about $300,000, including equipment. It will be located at Madison Ave. and East 5th St.

BROOKLYN—The Aetna Varnish Co., Maspeth and Vandervoort Aves., has plans under way for the erection of a new 1-story plant 80x100 ft., to cost about $20,000. Louis Allmendinger, 20 Palmetto St., is architect.

SPARKILL—The Standard Oil Co., 26 Broadway, New York, has preliminary plans under consideration for the erection of a new oil refinery on local tract of property recently acquired, comprising about 1,500 acres of land. The new works will consist of a number of buildings and is said to be estimated to cost in excess of $500,000.

YONKERS—The Kober Chemical Co., 24 Grey Oakes Ave., is completing plans and will soon call for bids for the erection of a 2-story chemical laboratory, 40x70 ft., on Grey Oakes Ave., estimated to cost about $42,000.

Ohio

EAST AKRON—The Trump Rubber Co., operating at the former local plant of the Denmead Rubber Co., manufacturer of mechanical rubber products, has plans nearing completion for the erection of a new local plant for the manufacture of automobile tires, to be equipped for an initial output of about 100 tires per day.

NILES—The Electric Alloy Steel Co., Youngstown, O., is perfecting plans for the erection of a new plant at Niles, to comprise open-hearth alloy steel furnaces, rolling mills, etc., for the production of high-speed steel products.

Oklahoma

OKLAHOMA CITY—The Kenyon Brick & Tile Co., 2700 West 10th St., is planning for the installation of new equipment at its plant, including mixing machinery, press, etc. A. W. Kenyon is president.

PONCA CITY—Miller Brothers, operating the 101 Ranch, will commence the immedi-

ate rebuilding of the tanning plant on their property, recently destroyed by fire. It will have a capacity of 200 hides per day, and with power plant and other works buildings, will cost about $100,000.

ARDMORE—The Indiahoma Refining Co. Federal Reserve Bank Bldg., St. Louis, Mo., is negotiating for the purchase of the local oil refinery of the Chickasaw Refining Co., which has been inactive for about a year past. Upon acquisition, it is purposed to make extensions and improvements, including machinery repairs, and place the plant in service at the earliest possible date. E. E. Schock is head of the Indiahoma company.

Pennsylvania

JEANETTE—The American Window Glass Co., Farmers' Bank Bldg., Pittsburgh, will take bids at once for the erection of an addition to its local glass plant, to duplicate, approximately, the present 12-tank building at the works. The installation will comprise twelve cylinder blowing machines, tanks, glass conveyors and other machinery. An appropriation of about $1,500,000 has been made for the expansion. William L. Monro is president and general manager.

WHITE HAVEN—The Peerless Explosive Co. will make extensions and improvements in the plant of the Miller Powder Works, Ice Lake, near White Haven, recently acquired, and plans to commence operations at an early date. Employment will be given to about 100 men.

ALLENTOWN—The Ford-Rennie Leather Co., recently organized under Delaware laws has leased the former plant of the Victor Leather Co., near the East Penn Junction, and will operate a tannery for the manufacture of glazed kid products. John D. G. Rennie is president; and James I. Ford, treasurer.

PHILADELPHIA — The M. L. Shoemaker Fertilizer Co., Venango St. and the Delaware River, is planning for the rebuilding of the portion of its plant, recently destroyed by fire, with loss reported in excess of $400,000, including buildings and equipment.

South Carolina

LAURENS—The Laurens Glass Works, Inc., has plans in progress for the rebuilding of the portion of the main building at its plant, recently destroyed by fire. Albert Dial is president.

Tennessee

KNOXVILLE—The Knoxville Porcelain Co., recently organized with a capital of $370,000, has acquired property at Lonsdale, near Knoxville, comprising about 5 acres of land, as a site for the erection of a new plant for the manufacture of porcelain products for electrical service. The initial works will consist of a 3-unit plant, estimated to cost about $100,000. J. N. Houser is president, and O. C. Duryea, vice-president.

MEMPHIS—The Commercial Chemical Co., 394 South Front St., is reported to be planning for the rebuilding for the portion of its works, destroyed by fire, Aug. 19, with loss approximating $40,000.

Texas

BEAUMONT—The White Eagle Oil & Refining Co., Kansas City, Mo., has tentative plans under consideration for the construction of a new oil storage and terminal plant here to cost about $250,000, including equipment, for export service. It is expected to commence work at an early date.

West Virginia

WIERTON—The Wierton Steel Co. will soon commence the installation of a new byproducts coke plant, to comprise a battery of 37 ovens and auxiliary equipment, with capacity of about 600 tons of coke per day.

Industrial Developments

LEATHER — The Charles S. Walton Co., Philadelphia, Pa., is increasing production at its tanneries. The currying plant has been placed on a full capacity basis.

The Griess-Pfleger Tanning Co., Cincinnati, O., is running full in its different plant departments, giving employment to a regular working force. A new hide and skin storage plant has been completed and will be placed in service at once.

CERAMIC — All refractory plants in the vicinity of Mount Union, Pa., are operating at capacity, giving employment to normal working forces, including the Harbison-

Walker Refractories Co., the General Refractories Co. and the United States Refractories Co. Wages have been advanced at the plants for all classes of employees, averaging from 60 to 80 cents a day; the schedule for laborers has been increased from $2.70 to $3.50 per day.

The Vitrified Brick & Tile Co., Collinsville, Okla., has adopted a night shift at its plant, in addition to a regular day force, and will operate on a basis of 5 carloads of material per day for an indefinite period. The company is said to have orders on hand for over 200 carloads of vitrified brick.

Owing to fuel shortage, a number of brick-manufacturing plants in the Akron, O., district have been forced to shut down or curtail production. Two plants are still running full. Operations will be resumed as soon as the situation improves.

Potteries at Trenton, N. J., are arranging for a full resumption of production as soon as a supply of anthracite coal is available. Fuel shortage has caused a number of the plants to curtail operations during the past few weeks. The present local supply of anthracite for this branch of industrial work is low.

A number of brick plants in Nansemond County, Va., and other parts of the state are refusing orders, owing to inability to make shipments and deliveries on account of the rail strike. The Virginia-Carolina Brick Manufacturers' Association has applied to the state fuel distributor, Richmond, to grant priority shipments to the industry.

IRON AND STEEL—The Trumbull Steel Co., Youngstown, O., has resumed operations at its plant at Warren at close to normal capacity, on a basis of about 40,000 tons per month.

The American Sheet & Tin Plate Co., Elwood, Ind., is maintaining active production at its local mills, giving employment to more than 500 men.

The Monterey Iron & Steel Co., Monterey, Mexico, is increasing production at its mills, and is now operating at practically full capacity. The steel output has been advanced from 400 to 500 tons per day, and will be further increased to a maximum of 600 tons at an early date. With three open-hearth furnaces in service, arrangements are being made to place the fourth unit at the plant in operation, at which time the working force will be increased by about 1,500 men. A recent increase in employees has been made from 2,000 to 3,500.

The Iron Products Corp., Bessemer and Anniston, Ala., has adopted a capacity basis of operation at all of its local plants, including coke works.

The Crucible Steel Co. of America is maintaining production at its Syracuse, N. Y., plant at close to normal, with employment of regular working force.

The Midvale Steel & Ordnance Co., Philadelphia, Pa., has adopted a present basis of operation of about 50 per cent of normal at its plants.

The American Sheet & Tin Plate Co. is increasing operations at its Shenango works, near New Castle, Pa., and has recently added about 100 men to the working force.

Owing to coke and coal shortage, blast-furnace operation in the Buffalo, N. Y., has been curtailed to 5 active stacks out of a total force of about 25,000 tons.

METALS—The American Smelting & Refining Co. is planning for the resumption of operations at its plant at Monterey, Mexico, which has been idle for a number of years past. The company is operating its smelting and refining plant at Tacoma at full capacity, giving employment to the regular working force.

The Utah Zinc Co., Salt Lake City, Utah, is running under heavy output at its local plant. The mill has orders on hand for some time to come for zinc oxide for the rubber and paint industries.

MISCELLANEOUS—The Darco Corp., Marshall, Tex., is running at full capacity at its local plant unit, recently completed, for the production of Darco, or coloring material for food products, and other service. The first full-car shipment has left the plant, and others will follow on a regular working schedule. Additional plant units will be constructed in the future.

The American Window Glass Co. is operating with a working force of more than 700 men at its plant at Jeannette, Pa., at close to normal output. A wage increase of from 15 to 22 per cent has been made.

The Lehigh Portland Cement Co., New Castle, Pa., has resumed operations at its local mills, following a recent curtailment due to a strike of operatives. The men have

been granted a 20 per cent wage advance. About 700 employees are affected.

The International Cement Co., New York, has been forced to curtail operations at its Knickerbocker cement plant, owing to the coal and rail strike. It is expected to resume as soon as the situation improves.

The Solvay Process Co., Solvay, near Syracuse, N. Y., is maintaining operations at its local plant at close to normal, with employment of regular working force.

Glass plants at Millville, N. J., are arranging for an immediate resumption of operations, following the regular seasonal shut down in July and August. A large force of men is busy in placing the plants in readiness for full blast. A number of plants have accumulated orders to insure capacity production for some time.

The Smithville Oil Mill Co., Smithville, Tex., has resumed operations at its local cottonseed oil mill, closed for a number of months past. Production will be increased gradually until a day and night force is engaged. It is expected to keep the plant running full well into the winter.

The J. R. H. Products Co., Willoughby, O., specializing in the production of barium dioxide, has closed its plant for an indefinite period, owing, it is said, to foreign competition. The plant has been giving employment to close to 100 men.

The McMurray Asphaltum & Oil Co., Waterways, near Edmonton, Alta., is arranging for immediate increased operations for the production of lubricating oils from tar sands. Machinery will be installed for this purpose.

New Companies

THE THOMAS ENGINEERING LABORATORIES, INC., Newark, N. J., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture paints, varnishes, etc. The incorporators are John H. Thomas, Milton A. Smith and Edward T. Moore.

THE BREWER MFG. Co., Grand Rapids, Mich., has been incorporated with a capital of $200,000, to manufacture spark plug porcelain products and kindred specialties. The incorporators are Ray E., John A. and C. G. Brewer, 1103 Front Ave., N. W., Grand Rapids.

THE HENDERSON OIL & REFINING Co., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under state laws with a capital of $1,000,000, to manufacture petroleum products.

THE NATIONAL PAINT WORKS, INC., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture paints, varnishes, etc. Philip Shurdut is president; and Frank V. Jordan, 237 Redlands Road, West Roxbury, Mass., treasurer.

J. C. SEITZ & Co., INC., Buffalo, N. Y., care of Dirnberger & Moore, attorneys, Buffalo, representative, has been incorporated with a capital of $200,000, to manufacture tires, tubes and other rubber products. The incorporators are J. C. and E. W. Seitz, and H. F. Robinson.

A. BELL & SON, INC., Providence, R. I., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are Hiram G. Hall, Clive D. Waite and John M. Clifford, all of Providence.

THE SULFEX Co., Newark, N. J., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are Louis C. Owens, Jr., Charles P. Stewart and Bertram W. Saunders, 264 Jelliff Ave., Newark.

THE MacINNES MFG. Co., 10925 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of $24,000, to manufacture paper, fiber and kindred products. The incorporators are Neil and M. V. MacInnes, and Harold L. Hart.

H. A. DEFRIES, INC., New York, care of N. F. Schmidt, 220 Broadway, representative, has been incorporated with a capital of $20,000, to conduct metallurgical operations. The incorporators are R. Chaplin, E. Goldberg and J. V. Ecker.

THE ACME PRODUCTION Co., New York, care of the Registrar & Transfer Co., 900 Market St., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of $2,500,000, to manufacture petroleum products.

THE CHLORIDINE Co., Memphis, Tenn., has been incorporated with a capital of $10,000, to manufacture chemical products. The incorporators are H. R. Bynum, P. C. Schalz and A. C. Grube, all of Memphis.

THE NEW PROCESSES Co., Indianapolis, Ind., has been incorporated with a capital

of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are George P. Shippey and Raymond L. Walker, both of Indianapolis.

MORRIS B. READE, INC., Nutley, N. J., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. . The incorporators are Jacob Muller and Morris B. Reade, 72 High St., Nutley.

THE PROCESS CHEMICALS, INC., New York, care of M. P. Schaffer, 1463 Broadway, representative, has been incorporated with a capital of $1,250,000, to manufacture chemicals and chemical byproducts. The incorporators are A. P. Burch, E. Stempel and L. E. Wolz.

THE COLUTH CHEMICAL CO., Indianapolis, Ind., has been chartered under state laws to manufacture chemical specialties. The incorporators are Howard C. Baker, William M. Love and Thomas M. O'Connor, all of Indianapolis.

THE METAL PENETRATING COLOR CORP., New Haven, Conn., has been incorporated with a capital of $25,000, to manufacture a special metal process known as penetrating color. The incorporators are George R. Doolittle and William H. Unmack, 152 Whalley Ave., New Haven.

THE CLARK CHEMICAL CO., INC., Boston, Mass., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. Nelson B. Clark, 166 Lawrence St., Malden, Mass., is president and treasurer.

THE NORTH AMERICAN OIL & MFG. CO., 2319 North Seeley Ave., Chicago, Ill., has been organized to manufacture refined oil products. The company is headed by C. J. Christie and E. A. Schillinger.

THE DAVID HASSETT CORP., New York, N. Y., care of Burnett, Sorg, Murray & Duncan, 810 Broad St., Newark, N. J., representatives, has been incorporated with a capital of $100,000, to manufacture fiber products. The incorporators are D. H. Hassett, G. B. Bailey and F. E. Stults.

THE WAXENE MFG. CORP., Bloomington, Ind., has been incorporated with a capital of $60,000, to manufacture waxes, polishes, varnishes, etc. The incorporators are Halbert M. Wood, Oscar H. Cravens and J. E. P. Holland, all of Bloomington.

THE CHICKASAW REFINING CORP., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., has been incorporated under state laws with a capital of $10,000,000, to manufacture refined petroleum products.

THE MERCHANTVILLE ALUMINUM & BRASS WORKS, INC., Merchantville, N. J., has been incorporated with a capital of $100,000, to manufacture aluminum, brass and other metal products. The incorporators are Peter Bernacki, Andrew Raroha and Dean S. Renwick, 511 Market St., Camden, N. J. The last noted represents the company.

THE KRISGOLD LEATHER CO., Chelsea, Mass., has been incorporated with a capital of $10,000, to manufacture leather products. George L. Goldman is president; and Jacob Kristal, 29 Franklin Ave., Chelsea, treasurer.

THE GULF STATES CHEMICAL & REFINING CO., Birmingham, Ala., has been organized to manufacture chemicals and chemical byproducts, and affiliated specialties. J. A. Moore, Jr., is president; and J. M. Gilby, Jr., vice-president, both of Birmingham.

L. HANERFELD, INC., New York, N. Y., care of Holley & Oxenberg, 50 East 42nd St., New York, representatives, has been incorporated with a capital of $15,000, to manufacture glass products. The incorporators are L. Hanerfeld, B. Finkelstein, and J. A. Sheridan.

THE ALLYNDALE LIME CO., Hartford, Conn., has been incorporated with a capital of $50,000, to manufacture lime and kindred products. The incorporators are Samuel Gilbert, Benjamin Gaberman, both of Hartford; and M. S. Tracy, Glastonbury, Conn.

THE UNIVERSAL SODA & POTASH MINES, INC., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., representative, has been incorporated under state laws, with capital of $60,000, to manufacture soda, potash and kindred products.

THE OGDEN PRODUCTS CO., 3258 Ogden Ave., Chicago, Ill., has been incorporated with a nominal capital of $5,000, to manufacture chemicals and affiliated products. The incorporators are Charles Martin Sals, William Greenberg and Daniel D. Lichtenstein.

THE MORGANTOWN MANTEL & TILE CO., Morgantown, W. Va., has been incorporated with a nominal capital of $5,000, to manufacture tile and other ceramic products. The incorporators are H. L. Winter, James Fancey and O. M. Herod, all of Morgantown.

THE BOLTA CO. OF AMERICA, care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under state laws with a capital of $1,000,000, to manufacture chemicals and chemical byproducts.

THE MARYLAND-VIRGINIA OIL CORP., 1010 Keyser Bldg., Baltimore, Md., has been incorporated with a capital of $500,000, to manufacture petroleum products. The incorporators are E. E. Hoch and L. R. Athey.

THE FRENCH MFG. CO., Seymour, Conn., has been incorporated with a capital of $50,000, to manufacture rubber specialties and affiliated products. The incorporators are C. M. and E. D. French, and C. J. Atwater, all of Seymour.

THE AETNA ALUMINUM & BRASS CASTINGS CO., 834-36 West 49th Place, Chicago, Ill., has been incorporated with a capital of $6,000, to manufacture aluminum, brass, bronze and other metal castings. The incorporators are F. A. B. Smith, William F. Bodong and Joseph A. Koehler.

THE TREMONT OIL CO., Chicago, Ill., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., representative, has been incorporated under state laws with a capital of $500,000, to manufacture petroleum products. The incorporators are R. W. Taylor, J. N. Fulton and T. Goodrich.

THE CROTON CHEMICAL CORP., New York, N. Y., care of N. L. North, Jr., 32 Court St., Brooklyn, N. Y., representative, has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts. The incorporators are H. H. Walker and N. P. Hicks, Jr.

THE BURKHART-SCHAIR CHEMICAL CO., Chattanooga, Tenn., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. A. C. Brukhart, Chattanooga, is president.

THE IDEAL MFG. CO., care of the Delaware Charter Co., 904 Market St., Wilmington, Del., has been incorporated under state laws with a capital of $80,000, to manufacture iron, brass, bronze and other metal castings.

THE MARION PRODUCTION CO., Marion, Ind., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are Omar F. Brown, Edgar S. Lane and Charles W. Beach, all of Marion.

THE OLD COLONY-RYNAK LEATHER CO., Boston, Mass., has been incorporated with a capital of $100,000, to manufacture leather products. Walter Reinstein is president; and Henry Yozell, 40 County Road, Chelsea, Mass., treasurer.

Capital Increases, Etc.

THE COMMERCIAL CHEMICAL CO. OF TENNESSEE, Memphis, has filed notice of increase in capital from $2,500,000 to $2,750,000.

THE NEWPORT CO., Carrollville, Wis., manufacturer of heavy industrial and other chemicals, has disposed of a bond issue of $3,000,000, for general expansion, operations, etc. J. W. Shaeffer is president.

THE GLEN FALLS PORTLAND CEMENT CO., Glen Falls, N. Y., has filed notice of increase in capital from $600,000 to $1,200,000, for general expansion.

A petition in bankruptcy has been filed against the BROWN LEATHER CO., 1153 West Roosevelt Rd., Chicago, Ill. The liabilities are said to total $35,000, with assets close to a like amount.

THE UNITED STATES RUBBER CO., Akron, O., has arranged for a bond issue of $7,000,000, the proceeds to be used for general financing, expansions, etc. C. B. Seger is chairman of the board.

THE CENTURY CUT GLASS CO., Saugerties, N. Y., has filed notice of dissolution under state laws.

THE CLINTON TIRE & RUBBER CO., Toledo, O., has filed notice of change of name to the Wildman Tire & Rubber Co., at the same time increasing its capital from $100,000 to $2,200,000, for proposed expansion.

THE CUBA CANE SUGAR CORP., 112 Wall St., New York, operating sugar refineries in Cuba, has approved a bond issue of $10,000,000, to be used for general financing in connection with its subsidiary, the Eastern Sugar Corp.

THE NEW YORK VITREOUS ENAMEL PRODUCTS CORP., a Delaware corporation, has filed notice of organization to operate in New York for the manufacture enamelware products, with capital of $100,000. J. R. Greenwood, 66 Myrtle Ave., Brooklyn, represents the company.

Industrial Notes

THE CONVEYORS CORPORATION OF AMERICA, Chicago, Ill., announces that the Florandin Equipment Co. has been organized by C. H. Florandin, with offices at 110 West 40th St., to act as its New York representative. The new organization will also do a general contracting business in and around boiler rooms and industrial plants located in New York City and its vicinity, erecting and installing the lines of equipment which the organization handles. The Conveyors Corporation of America has also appointed the Mid-West Engineering Sales Co., Masonic Temple, Cedar Rapids, Iowa, representative in eastern Iowa, for the sale of the American trolley carriers, which are coal-handling equipment of the monorail type. J. W. Holden, who is manager of the Mid-West Engineering Sales Co., is well known in Cedar Rapids and vicinity.

THE MORSE CHAIN CO., Ithaca, N. Y., announces that due to increasing business it was necessary to move the Philadelphia office to larger quarters. It is now located at 612 Franklin Trust Bldg., 18-22 South 15th St. J. A. Meaney is district manager for that office.

W. A. JONES FOUNDRY & MACHINE CO., Chicago, Ill., announces the opening of another branch sales and engineering office at 2482 University Ave., St. Paul, Minn. C. F. Ford, who is in charge of this new branch, is an experienced transmission engineer and qualified to assist in elevating, conveying and power transmitting problems.

CELITE PRODUCTS, LTD., has been established in Canada to market Sil-O-Cel and Filter-Cel, as produced by the Celite Co. in the United States. Stock of these materials will be maintained in the New Kirks Bldg., Montreal. Lawrence Russel has been appointed manager.

THE J. R. ALSING ENGINEERING CO., 50 Church St., New York City, established in 1869 to develop pebble mills in this country under patents issued to J. R. Alsing in the early '70s, has recently undergone a reorganization. It has been taken over by W. W. Searle and Edward W. Lawler, the latter acting as general manager of the company. Mr. Lawler was previously manager of the Harding Co. of New York, which position he left 2 years ago.

THE BUCKEYE DRYER CO. has removed its main office from 243 North High St., Columbus, O., to 29 South LaSalle St., Chicago, Ill.

LESLIE H. WEBB, vice-president of the Wedge Mechanical Furnace Co. of Philadelphia, has recently assumed the management of the Pittsburgh offices of the Pennsylvania Salt Mfg. Co., the parent company of the Wedge Mechanical Furnace Co.

Coming Meetings and Events

ALPHA CHI SIGMA dinner, during the Chemical Exposition, will be held Thursday, Sept. 14, at 6:30 p.m. at Keen's Chop House, 107 West 44th St., New York City. Members are requested to register at *Chem. & Met.'s* booth at the Exposition.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN GAS ASSOCIATION will hold its annual convention and exhibition at Atlantic City, Oct. 23 to 28.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its 126th meeting at San Francisco, Calif., Sept. 25-29, 1922.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS is holding its sixteenth annual convention Sept. 11 to 15 at Cleveland Public Hall, Cleveland, Ohio.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) is being held in New York, Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer, but will resume them in October.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a 3-day national convention in New York, beginning Oct. 18. The general topic of the convention is "Economics of Industry."